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Remarks on the Application of Steam to Ships of War. By WILLIAM N. JEFFERS, U. S. Navy.

The evident superiority which a steamer possesses over sailing vessels, in the navigation of the rivers and along the coasts, and, within late years, the success of extended voyages by steamships, has very naturally suggested the more extended application of steam to ships of war. The advantages of rapidity and certainty of transit, her independence of fickle winds and adverse tides, are so striking, that even the least conversant in naval affairs esteems himself competent to decide the question, and joins in the cry which denounces as "old fogyism," the expression of a doubt as to the ultimate advantages to be derived from the substitution of steam for its more economical rival.

To the present time, this asserted superiority has not been proved to exist, and it is very doubtful whether the efficiency of the navy, far less that of an individual ship, has been increased by the means already adopted.

I have been led to make these remarks, by reading in an article in the July number of this *Journal*, from the pen of a distinguished authority, (W. Fairbairn,) the following:

"Steamers can back out of difficulties and dangers, when sailing vessels must remain exposed; they can assail the enemy at a great distance, and take up any position they choose; and with their great guns and long range, inflict severe punishment, and do great execution, without receiving a single shot."

We have here in five lines five assumptions, at least four of which we think erroneous, and shall proceed to state the grounds for our opinion.

We do not pretend to deny any advantages which may be claimed for the steamer in a littoral warfare; but for that purpose celerity of motion, light draft of water, and capacity for the accommodation of large bodies of troops, are indispensable. Such enterprises are not successful by reason of any force in the steamers, but in their unexpected presence in front of the enemy, or success in clearing natural or artificial obstacles, supposed sufficient to bar their progress.

That this view of the case is a correct one, is shown by our own operations in the Gulf during the war with Mexico, and the warfare of the English in China. The vessels employed on these occasions were in no respect capable of sustaining an action with sailing ships of war, and owed their success to the weakness and unprepared state of the enemy; they were common steamboats, purchased for the occasion, and for similar occasions always to be procured at a day's notice.

But the principal duties of a navy are upon the open sea; engaged in convoying our own merchant ships; the capture of the fleets of the enemy; the destruction of his commerce; cutting off his supplies; capture of colonial dependencies; the transportation of large bodies of troops from point to point, and the blockade of his harbors. These are the duties of the navy. But if called upon to man floating batteries, and to defend harbors which may be better protected at less cost by permanent fortifications, or to land in large bodies, and effect permanent lodgments on the enemy's territory, good seamen are at an enormous cost turned into indifferent soldiers. To perform these specific duties, suitable ships in sufficient numbers must be provided. What are suitable ships?

A man of war, to be efficient, must be able to keep the sea for a considerable period, certainly four months; otherwise, her frequent entrance into port for supplies, would give the enemy all the information he desired as to the force, destination, and cruising ground of the fleet or ship. None but the smallest sailing vessels are forced into port oftener than once in four months, while the larger ships may keep the sea six months. Steamers of full power, that is, those capable of making ten knots and upwards under steam alone, are unable to carry more than fifteen days' fuel, which may be made to last with very moderate speed double that period, or thirty days, and without fuel they are comparatively helpless; consequently, when the scene of the intended operations is distant, the sailing ship can reach the rendezvous in as short a time as the steamer. The greatest distance yet passed over under steam was about 4000 miles, at an average rate a little less than eight miles an hour; while the passage of the *Flying Cloud* to San Francisco exceeded the rate of eight miles and a half an hour, and was but three or four days longer than those of the *Golden Gate* and *Winfield Scott*, two crack steamers, which were forced to make three ports by the way. The propeller steamship *S. S. Lewis* reached San Francisco in 124 days, beaten by nine-tenths of the California fleet.

It may be objected to this comparison, that our men of war do not equal the *Flying Cloud* in speed; nor are the steamships in this respect equal to the *Golden Gate*. The speed of our men of war is not, however,

to be judged of by their passages, for we have no object in forcing our ships, and under ordinary circumstances in time of peace, no officer is justified in risking the smallest spar; the object of the cruise is accomplished by the presence of the ship on the station. Nevertheless, the passages of some of our ships have never been equalled by the finest of the clipper fleet.

We are of opinion, therefore, that it is not proven that the steamer possesses any great advantages in making a passage, except under peculiar circumstances of constantly adverse winds and currents, when the distance is greater than the steamer is enabled to make without calling at a port or ports by the way.

Hitherto we have considered the relative capabilities of the two ships for keeping the sea or making a passage, but it must be evident that this is one of the least of the conditions to be fulfilled.

The extent of a navy being governed by the ability of the nation to sustain the cost of construction and maintenance, the steamship ought to be of at least equal military force with her sailing rival of the same cost; else, on her arrival at her destination, she will be forced to accommodate herself entirely to the movements of the enemy. On this point, the relative force of the two ships, the most erroneous notions prevail. One gun mounted upon a steamer is assumed to be equal to the battery of a ship of the line. This notion is, however, but the reproduction of a long since exploded system; that of a navy of gun-boats, for steamships are but gun-boats moved by steam instead of sweeps. "In calms, gun-boats are the sovereigns of ships of the line," says an able writer; and from naval histories he gives terrible examples to prove the truth of his assertion. The system no longer has an advocate, and experience has proved that individual examples to the contrary do not invalidate the general rule that superior force must ultimately triumph.

The great fallacy upon which the enthusiast and the ignorant base their argument in support of this opinion is, that steamers are able to assume at will any position, in spite of the efforts of the sailing ship. They begin with the assumption, that a dead calm prevails, and their adversary floats motionless on a glassy sea, "like a painted ship upon a painted ocean," helpless. This assumption cannot be granted, for an examination of the logs of many ships shows that calms are by no means common; in fact, that, except in the close proximity to land, and in certain latitudes easily avoided when lying in wait for an enemy, it is very uncommon for a ship not to have steerage way. We will, however, admit, that it is during a calm that a well appointed steamer falls in with an equally well prepared frigate. The effective range of the eight and ten inch shell guns, with which steamers are armed, is about 1200 yards, and of course, with her very small number of guns and ability to choose distance, it is her advantage to maintain the distance which makes her gunnery most effective. At this, as well as at any other distance, the eight inch shell guns of the frigate are at least as effective as those of the steamer, while the whole battery of 32's will tell with solid shot; consequently, the steamer must avoid the frigate's broadside; but to pass over a quarter of a circle to get from the broadside to the stern or bow of the sailing ship, she must pass over a distance of 2000 yards, which at eight miles the hour, takes eight minutes. Now, will any seaman believe that

the direction of the ship's head cannot be altered eight points in as many minutes? The two quarter boats, with a line from the end of the jib-boom, will tow her round; or parachute drags may be laid out abeam, (with a similar machine the late Com. Porter propelled the *Essex* three miles an hour;) or an athwartship propeller, as proposed by R. L. Stevens, Esq., and a similar one experimented on in England, worked by hand or a small engine of ten horse power. Other methods will doubtless suggest themselves; so that, in our opinion, this idea of choosing position is altogether delusive. If the steamer closes to a less distance, she comes within range of a broadside of 6½ inch shells, which, though not quite equal to the 8 inch, are yet quite sufficient for the purpose, and the steamer fights at the terrible odds of six guns to fifty.

Should the frigate be fallen in with in a good working breeze, the steamer can only choose distance, (and that only in case of being faster,) but has still less opportunity of selecting position.

Even if we grant the steamer the claimed choice of position, the advantages to be derived from this are not by any means evident; the sterns of ships are no longer made for ornament alone; a frigate can in half a minute shift six guns from her broadside to her stern, which is, in proportion to its developement, as formidable a battery as her broadside; added to which, the steamer being herself in motion at a rapid rate across the line of fire, delivers her shot at a greater disadvantage than the sailing ship, which is either quiet or slowly rotating on her heel. Steamers when not under sail are particularly uneasy in a sea-way, making the pointing their guns very difficult.

But, say the advocates of the steamer, she being armed with larger and heavier guns, will lay off abeam out of danger, and hammer her adversary without caring to choose position. This is another assumption not borne out by the facts. The steam frigates *Saranac* and *San Jacinto** each mount six eight-inch guns; four in broadside, the other two on pivot carriages; the whole may be fought on one side.† The first class frigates mount each fifty guns; eight of which are eight-inch, the remaining forty-two are of 32 lbs. calibre; by shifting over, thirty-two guns may be fought on one side. The two pivot guns are of slightly greater power than any gun on board the frigates *as now armed*, but not to such an extent as to overcome the disparity of six to thirty-two. This disparity in numbers must always exist, for the steamers are already loaded down with their machinery and battery, and any increase of guns requires a corresponding addition of men, ammunition, and provisions. The disparity in the power of the guns may be met by putting corresponding guns on the frigates; this has been done in the case of the small frigate *Raleigh*, which mounts two heavy eight inch guns on pivots, twenty common eight inch shell guns, and two long thirty-two pounders. We must confess that on comparing this ship with the *Saranac* or *San Jacinto*, we cannot believe that any advantages of position likely to be obtained by the steamer can compensate for her decided inferiority of four to one in military force.

The *Mississippi*, carrying no long guns, is, in our opinion, decidedly inferior to the preceding steamships; while the *Susquehanna* and *Powhattan*

* We prefer choosing illustrations, when practicable, from our own service.

† This is, however, at sea, a questionable advantantage; the heel towards the enemy caused by shifting over permits the deck to be *commanded*.

are but larger editions of the *Saranac*, and in force, as in cost, are only to be compared with ships of the line. As to the *Princeton*, her armament of four light eight inch guns, and six light thirty-two pounders, is decidedly inferior to that of any first class sloop in the navy. The first class sloops mount twenty-two guns of greater power, and would bore her through and through before she could effectively return a shot.

The favorite policy of keeping at a distance led to a preference of a few guns, and those of great calibre, more particularly adapted to the firing of shells. There are, however, certain practical difficulties in the handling of heavy guns and their shot, which very much diminish their theoretical superiority over the thirty-two, which is the calibre generally used in the frigates. In mere *range*, the eight and ten inch guns are not equal to the thirty-two, as may be shown by reference to the Ordnance Manual; and being armed with shell guns, to the exclusion of solid shot, except at short ranges, the steamship is within the reach of shot long before her guns would tell. Shells are very far inferior in both range and accuracy to shot, and in view of this, the preference of shell guns does not appear to rest on a sound basis, but is a mere theory; they are as yet untried in actual warfare, and the records of authentic practice show that not more than one-fifth the shells fired at a target placed at a known distance, explode satisfactorily. The frigate, therefore, has at great distances numerous solid shot guns for deliberate fire, and at closer quarters, a broadside of either, or a mixed volley of shot and shell, with a numerical superiority of six to one.

The heavy guns placed on the bows and sterns of steamships, are necessarily mounted on pivot carriages on the spar deck, which makes it necessary to remove the bulwarks, either entirely, as in the *Saranac*, or partially as in other steamers. This exposes the *personnel* at all distances to effects of shell, and particularly the spherical case or shrapnel shell, and at close quarters to grape. The eight inch spherical case, containing about 400 missiles, may be employed at a range of 2500 yards, a distance beyond the effective range of any other species of projectile. The principal battery of the frigate is entirely protected, and the spar deck except from a raking position, in which last case, the exposed guns being inoperative may be temporarily abandoned, and the men sheltered.

We have now to consider the steamer when forming a part of a fleet. Here, forming a part of the line of battle, the integrity of the formation must be preserved; she has no opportunity of selecting her position; her usefulness is dependent on her absolute force, and she may be crushed at once by the superior ship to which she is opposed. If she keeps aloof, or acts the part of a tow boat, her armament is inoperative, and she renders no service to compensate for her cost. But she cannot be depended upon for towing; she may be disabled, or the tow rope may be cut by shot; this last is not a hypothetical case, for the loss of a Danish ship of the line during the late troubles with the Dutchies, was owing to this cause. The tow cannot be under sail; consequently, once adrift while making sail, she is, for a short time at least, an unresisting target. The true position of the steamship is as a reserve for assisting disabled vessels, not a principal actor in the fight.

There is one point in the paragraph we have quoted which we have

not as yet attempted to dispose of. That "steamers can back out of difficulties and dangers, when sailing vessels must remain exposed," we must in the abstract admit; but in order to give them this faculty there is no necessity of depriving them of four-fifths of the military force due to their tonnage. In the side wheel steamship in our service, the engines and fuel occupy nearly, if not quite, half the whole space beneath the water line. In the *Princeton*, if all her fuel was below, not less than three-fifths of her entire capacity would be occupied by machinery, fuel, and stores; so that no economy of space, at least in this instance, is gained by the propeller. The English steam frigate *Arrogant*, which has become quite familiarly known to the readers of this *Journal*, and celebrated for her efficiency, carries but forty guns, when the battery due to her tonnage is sixty; to compensate for this diminished force, she carries but eight days' coal, steaming at sea at a maximum rate of 5·08 knots, (*Vide Jour. Frank. Inst., May*, 1852.) This is probably the maximum rate at which it is necessary that a war steamer should be propelled; it is ample for all the purposes of manœuvring, and for making head against the most rapid currents of the ocean. The boilers and machinery necessary occupying but a limited space, may be placed with, say ten days' coal, far below the water line, and when necessary, fifteen to twenty days' coal may be carried in bags. The risk of accident, which forms so serious an item to their disadvantage, to be allowed for in comparing the efficiency of the present steamers, is reduced to a mere trifle. Further improvements may be expected in the engines and boilers, and models of the ships, (the *Arrogant* is by no means a good model,) and we may succeed in giving a steamship this velocity without displacing so great a portion of her battery as to seriously affect her force.

To the present time, then, we assert that military efficiency has been sacrificed to speed, without attaining the latter, and nothing but a mongrel has been produced, as must always be the case when we aim to combine in one, several contradictory qualities. We require for one purpose, great military force, with sufficient power to render it available when calms, contrary winds, or adverse currents prevent our approaching in sailing vessels the object to be attacked; and for the other, great speed, room for the accommodation of troops, and moderate draft of water.

The first is to be obtained by applying to every ship a small propelling apparatus, the drag of which will not materially affect her sailing qualities when not steaming, but which will be sufficient to manœuvre her in presence of the enemy, enable her to enter ports, or pass through regions of calms to those of favorable winds.

For despatch vessels and troop ships, the mail steamships now in existence under contract with the government, are admirably adapted; they can carry a sufficient battery for the purposes of defence, and their speed insures them impunity where superior force is concerned. It is unnecessary to discuss in this paper, whether it is a wiser policy to continue the subsidies to these steamers and establish new lines of similar vessels, or to build vessels of similar qualities, or to trust to the natural developement of commerce. We have combated what we believe to be false positions and fallacious arguments, and have indicated the wants and requirements

of the Naval Service. The facts are indisputable, the inferences we think legitimate.

Naval officers are, of all others, most interested in this subject, for they feel that much will be expected of them in a future war, and they *know* that the means placed at their disposal are not capable of producing the required effects.

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*Drainage of Haarlem Meer.**

It appears from a paper by Mr. Grainger, C. E., before the Scottish Society of Arts, that this great work is nearly approaching its completion. The pumping was commenced in May, 1848, from which date to April 30, 1851, the lake had been lowered 7 feet 3 inches, which was the state of matters when the subject was last brought before the Society. During the months of May, June, July, August, September, and October, very satisfactory progress was made, notwithstanding that a considerable quantity of rain fell in August and September, the level reached at the end of October being 9 feet 7·74 inches below the original surface, or at an average rate of 4·79 inches per month. In November a great quantity of rain and snow fell, raising the level about 4 inches; and in December the weather was still unfavorable, so that at the end of the month the level stood at 9 ft. 5·58 in. below the original surface, or a total gain since April 30, of 2 feet 5·58 inches, or 3·32 inches per month. This progress may appear to be inconsiderable; but, when it is recollected that the lowering of the lake one inch involves the raising of upwards of four millions of tons of water, and allowing for the rain and snow falling during these eight months, there could not have been less than 186,000,000 tons of water pumped up during that period, the performance will appear great indeed. To give a better idea of this, it was stated that 186,000,000 tons was equal to a mass of solid rock one mile square and 100 feet high, allowing 15 cubic feet to a ton. The average progress has been less last year than it is in the preceding one; but this is readily accounted for by the *increased lift* of the pumps, and by the difficulty of forming the channels which lead the water to them. At the commencement of these operations, the average depth of the lake was 13 feet 1·44 inches, and as 9 feet 5·58 inches have been pumped out, there only remained at the end of December last an average depth of 3 feet 7·786 inches. It is, therefore, trusted that the drainage will be completed, if not in the autumn of this year, at least in the summer of 1853.

Ordnance Range and Velocity.†

The longest range and greatest velocity ever accomplished by any ordnance, ancient or modern, up to the period of 1840, and we believe to the present time, is 5720 yards, or just three miles and a quarter. The whole time of flight was only thirty seconds and a quarter, which is estimated at 2100 feet in the first second of time. The piece of ordnance

* From the London Mechanics' Magazine, July, 1852.

† From the London Practical Mechanic's Journal, July, 1852.

used on this occasion was a fifty-six pounder cannon, cast on the principles of Mr. Monk, who suggested the propriety of removing a considerable proportion of useless metal from the gun before the trunnions, and adding it to the breech, where alone increased strength is desirable. This arrangement permits the use of a larger projecting charge of gunpowder, without risking the calamity of bursting. The quantity of powder employed in the experiment alluded to was ten pounds, and *the ball weighed sixty-two pounds and a half*, a circumstance which requires some explanation, seeing that we have stated the gun to be a fifty-six pounder. The explanation is this: the momentum of a projectile is the product of its mass and its velocity; by increasing that mass, therefore, or, in other words, by adding to its weight without adding to its size, we acquire a proportionate increase of momentum, and a consequent increase of range. The shot on the present occasion was an iron shell filled with lead; hence its weight of sixty-two pounds and a half. Nearly the same range was accomplished by the French during the Peninsular war, who threw shells into Cadiz, rather more than a distance of three miles; they, however, used enormous mortars, one of which is at present in St. James's Park, and employed the largest charges of gunpowder ever known in modern times; the missiles projected, moreover, were shells *nearly* filled with lead, the remaining space containing gunpowder, ignitable by a fuse, as in the common shell. The fact that leaden balls accomplish a longer range than iron ones, seems to have been discovered at least *once* by chance, the discoverers being totally ignorant of the principles on which the circumstance was founded. It is related that, during the war, an American ship having expended all her cannon-balls, and being unable to procure others of a similar kind, had some prepared of lead; when, on employing them in a subsequent action, her captain and crew were surprised at their long range and efficacy. Sir Howard Douglas is so satisfied of their advantages on peculiar occasions, that he recommends their introduction in the navy.

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*Death of Sir James Macadam.**

Sir James Macadam, the originator of the modern system of "macadamizing" roads, died on Wednesday in week before last, at his residence in Finchleysroad, London.

Enclosure of Land from the Sea in the Netherlands.†

The first sod of the lands conceded to the Netherlands Land Enclosure Company by the Government of Holland was turned by Captain Pelly, on Thursday in week before last, at Hanswerk, Zealand, Holland, in the presence of a large concourse of the population. In the Scheldt, between Bergen-op-Zoom and Antwerp, there exist large tracts of land covered at high water by the sea, and at low water presenting a varying surface of several feet in depth of the richest alluvial soil, ever on the increase. To redeem and dispose of this land is the object of the company named, which is composed of practical men on both sides of the Channel, with Sir

* From the London Builder, No. 494, July 24, 1852.

† From the London Builder, No. 492.

John Rennie as engineer-in-chief. The necessary powers have been granted for ninety-nine years from last August, under which the company may recover and enclose land to the extent of 35,000 acres. The reclamation will cost 20*l.* per acre they say, and the land reclaimed will be worth from 60*l.* to 70*l.* per acre.

AMERICAN PATENTS.

List of American Patents which issued from Sept. 14th to Oct. 5th, 1852, (*inclusive,*) *with Exemplifications by* CHARLES M. KELLER, *late Chief Examiner of Patents in the U. S. Patent Office.*

17. For an *Improvement in Clothes Pins;* Samuel Aldritch, Springfield, Vermont, September 14.

Claim.—"I do not claim the invention of pins for securing clothes to the line; neither the invention of the coiled spring or lever; neither the combination of the parts of the same. But I do claim the improvement of manufacturing clothes pins from wire of any suitable metal, with the aforesaid jaws attached, operated by a spring or lever, as being the most simple, cheap, effective, and durable, of any kind in use."

18. For an *Improvement in Connecting Joints for Washing Machines or other purposes;* S. L. Egbert and S. W. Green, Willoughby, Ohio, September 14.

Claim.—"What we claim as our invention is, the construction of the joint, (by which the connecting rod is attached to the spring board,) by means of the knife edges disposed in a right line, and confined by the straps and backing piece, substantially as herein set forth."

19. For *Improvements in Printing Presses;* Charles W. Hawks, Boston, Massachusetts, September 14.

Claim.—"Having fully described the construction and operation of my improvements, I will now point out the parts which I claim as my invention.

"1st, I claim a pair of nippers, so constructed as to draw the paper from the form, by griping the margin of the paper firmly between the jaws of the said nippers, and at the same time holding the paper a little distance from the platen, as herein described and set forth.

"2d, I claim the adjustable spring and rod, for holding the nippers up from the platen, as herein described.

"3d, I claim the fingers for holding the edge of the sheet, in combination with the swing platen, as herein set forth."

20. For an *Improvement in Lightning Rods;* Herman H. Homan, Cincinnati, Ohio, September 14.

"The object of my invention is the production of a self-renewing lightning rod point, of the greatest possible efficiency of operation and simplicity of construction."

Claim.—"Having thus fully described the nature of my improvements in lightning rod points, what I claim therein as new is, 1st, The formation of the point of a lightning rod of successive sections of different metals, each being of greater fusibility than the one below it, and having oblique junctions, so that an overcharge of the electric fluid simply melts off the upper section, without enlargement of the point below, either by its own partial fusion or by the lodgment of the upper metal upon it.

"2d, Uniting the successive sections of an obliquely sectional lightning rod point, by solder or brazing, which is at each joint fusible at a lower temperature than the section immediately above it, so that the melting of the point shall remove the entire uppermost section, and thus more certainly prevent the lodgment of any portion of the melted section upon the point thus exposed."

21. For an *Improvement in Smut Machines;* Charles and James Keeler, Union, New York, September 14.

"The nature of my invention consists in constructing the wind passages and spouts in

such a manner as to allow of their being turned to either side, to allow the machine to be driven in either direction."

Claim.—"What we claim as our invention is, making the blowing apparatus, with the drawer and spout, movable, substantially as described, so as to allow of the wind-chest and pipe being easily taken out, and turned in either direction, to admit of the machine being driven in whichever direction may be desired."

22. For *Machinery employed in the Manufacture of Coiled Wire Ferrules;* William T. Richards, New Haven, Connecticut, September 14.

Claim.—"I am aware that clamps or holders and cutting dies have been worked by cranks and cams; I therefore do not claim these, as such, as my invention. But what I claim as my invention is, the method of cutting the wire at right angles to the axis of the coil, so that the ends of the ferrules will be perfectly true, without wasting any of the stock, by the use of the short mandrel, the clamp or holder, and the cutting die, when the machine is constructed, arranged, and made to operate substantially as herein described.

"I also claim the combination of the method of cutting the coil (as described above) with the method of supporting the long coil, and of feeding it, and of throwing off the piece when severed, when combined, arranged, and operated substantially as herein described."

23. For an *Improvement in Shuttle Guides to Looms;* Horace T. Robbins, Lowell, Massachusetts, September 14.

Claim.—"I claim as my invention, 1st, The guide or its equivalent, either with or without the flanch, in combination with cloth-weaving looms, or as applied and used therewith, substantially in the manner and for the purpose of guiding the shuttle as specified.

"2d, I claim the spring and finger, or their equivalent, so arranged as to hold the guide in its proper place, substantially as specified."

24. For an *Improved Machine for Manufacturing Porte Monnaies;* Benjamin S. Stedman, West Meriden, Connecticut, September 14.

"This invention relates to certain means of inserting the leather or other material of which the sides of the porte monnaies and other similar cases are made, in their metal frames, by which a great saving in manual labor is effected, and the work performed in a better manner than by the common method."

Claim.—"What I claim as my invention is, 1st, The manner, substantially as described, of putting the leather or other material in the frames, by forcing a sufficient quantity through the frame, with a die or plunger, at the back side, and then by a larger die pressing the part so forced through, and folding it over the inner edge of the frames.

"2d, The form and construction of the clamp, which holds the frame and the leather or material, to wit: the lower part having an opening just large enough to allow the die on the back side to pass through, and the upper part having an opening large enough to allow the larger die to pass through, and fold the leather or material over the frame, and having a recess in its inner or bottom face, around the said opening, to receive and hold the frame in it, so that the leather or material is held independently of the frame, and allowed to be drawn through the frame, substantially as herein described."

25. For an *Improvement in Door Locks;* William Moore, Williamsburg, New York, Assignor to James Carman, City of New York, September 14.

Claim.—"The dividing plate being well known, is public property; therefore, forms no part of my claim: neither do I claim any of the parts operated from the outside key-hole, as these may be of any usual form. But what I claim is, the tumbler, enclosed by the dividing plate, to be operated on solely by the key, when entered from the inner key-hole, in combination with the revolving check, or its equivalent, and the bolt, for the purpose and as described and shown."

26. For *Improvements in Forging Machines;* George H. Richards, West Roxbury, Assignor to Calvin G. Plimpton, Walpole, Massachusetts, September 14.

Claim.—"I claim the sliding guide traversing upon the side bars, as described, having a pin, pivot, or fulcrum, one end of which is attached to the sliding guide, while the other end of the hammer, in which it is so fitted as to allow the hammer to turn a short distance, when power is applied to it by means of the crank, cam, or eccentric and the connecting rods."

27. For an *Improved Alarm Time Piece for Lighting Lamps;* William H. Andrews, Cheshire, and Randal T. Andrews, Plymouth, Connecticut, September 21.

"Our improvement consists in using a longitudinal section of a hollow cylinder, placed vertically in the lower part of the case of the time piece, with the lamp, match, &c., placed in it, so as to be within the case when not in use, but so that when the alarm is let off, the cylinder will be revolved one-half of a circle, the lamp lighted, and presented in front of the case of the time piece, for the convenience of the user."

Claim.—"What we claim as our invention is, the use of a revolving vertical section of a cylinder, when combined with a spring to revolve it, when these are combined with the appropriate levers, and connected with the alarm wheel of an alarm time piece by an appropriate connecting rod, for the purpose of lighting a lamp, in connexion with the alarm given by an alarm time piece, when the whole is constructed, combined, and arranged substantially as herein described."

28. For an *Improvement in Tuning Pegs for Guitars, &c.,* James Ashborn, Wolcottville, Connecticut, September 21.

Claim.—"What I claim as my invention is, making the tuning pegs of guitars and other like stringed instruments, with the journal part of much greater diameter than the barrel on which the string is coiled, substantially as and for the purpose specified."

29. For an *Improvement in Carving Machines;* Charles E. Bacon, Buffalo, New York, September 21.

"The nature of my improvement consists in giving to a vertical or inclined cutter, a motion laterally in any direction, at the same time it has a rapid rotary motion, for the purpose of producing a fac simile of any pattern or device, or for carving or cutting from patterns or originals previously made, or for cutting a pattern or device which shall be the reverse of the original, that is, having projections where there are cavities in the original, and vice versa."

Claim.—"What I claim as my invention is, the folding frame and wheels or pullies, constructed substantially as above described, in combination with the double cross sliding ways and vertically sliding cylinder or tracer, for the purpose of tracing from patterns or other device, in the manner above specified."

30. For an *Improvement in Coating Iron with Copper;* Theodore G. Bucklin, Buffalo, New York, September 21.

Claim.—"Having thus described my invention, I do not claim the preparation of iron with zinc, in the manner described; but I claim, 1st, Coating cast, malleable, or wrought iron, with copper, or any of the alloys of which copper forms a part, by employing a coating of zinc, or zinc and tin, to cover the iron, as a positive medium to make the molten copper or its alloy adhere to the iron, in the manner substantially as described.

"2d, I claim the employment of an infusible or partially infusible substance or substances, especially the fluoride of calcium, as a wiper and non-conductor, as herein set forth."

31. For an *Improved Hand Drilling Machine;* Reuben Daniels, Woodstock, Vermont, September 21.

Claim.—"What I claim as my invention is, the combination of the geared mandrel, which elongates, to feed the drill, with the arm that projects from the sleeve, to steady the gearing, and the slot in the stock, to guide and steady the arm, while traversing therein, to permit the drill to be advanced and withdrawn, as herein set forth."

32. For an *Improvement in Horse Collars;* J. H. Hall and John Lowrey, Wheeling, Virginia, September 21.

"Our invention consists of a metallic framed collar, which can be expanded or contracted to suit horses of different size, and which maintains the parallelism of its sides, however much it is expanded or contracted."

Claim.—"We do not claim a rigid collar, nor a collar capable of expansion and contraction sidewise, when the sides are connected by a third or intermediate part, or supported by a frame; but what we do claim as our invention is, the construction and arrangement of the two sides of the collar, so that they fit together, and can be moved towards and from each other by a parallel motion, to diminish or enlarge the aperture for the horse's neck, and then be fastened by a set screw, or its equivalent, to form a rigid frame, substantially as herein described."

33. For an *Improvement in Portable Wardrobes;* Seth L. Hobart, Hingham, Massachusetts, September 21.

Claim.—"Having thus described my improved wardrobe, what I claim as my invention is, a wardrobe susceptible of dismemberment, with the parts held together by means of the sliding bolts, which fit into sockets, and the notched studs, which fit into the grooves, the top piece preventing the back from slipping by the bolts, and the sides being prevented from slipping by the projecting pieces, which press the braces forward, and keep the studs pressed forward as above described."

34. For an *Improvement in Machinery for Beveling the Edges of Skelps or Metallic Strips &c.;* Robert Knight, Cleveland, Ohio, September 21.

"The nature of my invention consists in the arrangement of rollers in a frame work, so to receive a lateral movement or end play, one over the other, for the purpose of increasing or diminishing the distance between bosses on the rollers, according to the width of the strip or plate of which the flues and pipes are made."

Claim.—"What I claim as my improvement is, arranging the rollers in the frame, so as to receive a lateral movement as may be desired; in other words, giving the rollers end play, one over the other, as thereby increasing or diminishing the distance between the bosses, (according to the width of the plate or strip,) and providing suitable means for retaining the same in place."

35. For an *Improvement in Rakes;* Amza B. Lewis, Brooklyn, Wisconsin, September 21.

Claim.—"What I claim as my invention is, the combination of the slotted, swinging arm with the slotted rake handle and crank, in manner as above described, for moving the cut grain from the platform."

36. For an *Improvement in Paper Cutting Machines;* James E. Mallory, City of New York, September 21.

Claim.—"Having fully described the nature of my invention, what I claim as new therein is, the arrangement of the movable platform and sliding clamp, as described, in combination with the vibrating knife, as described."

37. For an *Improvement in Crayon Rubber;* Daniel F. Pond, New Haven, Connecticut, September 24.

Claim.—"I do not claim as new, the casting of particular forms of vulcanized rubber in moulds; but what I do claim as my invention is, the crayon rubber, made in the manner herein before substantially set forth, for the purpose of applying and blending the crayons in the bi-chromatic and other kindred styles of drawing."

38. For *Application of a Free Joint Tube in circumstances where it is exposed to external pressure;* Richard Prosser, Birmingham, England, Assignor to Thos. Prosser, City of New York, September 21; ante-dated May 31, 1852.

Claim.—"What I claim as my invention is, the application of the improved metal tube, made in the manner and for the purposes as herein before described, that is to say, of a metal tube with a free joint, (neither welded nor brazed,) to boilers of steam engines or other vessels requiring metal tubes, of such a character as to resist external pressure effectually."

39. For an *Improvement in Galvanic Clocks;* Moses G. Farmer, Salem, Massachusetts, Assignor to himself and Charles C. Coffin, Boscowen, New Hampshire, September 21.

Claim.—"What I claim as my improvement or invention is, the combination of the impulse spring and the pallets, respectively connected with the armatnre of the magnet and the pendulum, and made to operate together, and to make the pendulum operate or impart impulse to it, substantially as described."

40. For an *Improvement in Shoes and Gaiter Boots;* Joseph Brackett, Swampscott, Massachusetts, September 28.

Claim.—"What I claim as my invention is, the improved gaiter boot or shoe, as made with a lap piece separate from both the quarters, and extended up from the instep part of it, in combination with so applying button holes and buttons, or their equivalents, to the said lap piece and the two quarters, as to enable the two quarters to be directly connected by the lap piece, all substantially as above specified."

41. For an *Improved Jointed Bed Plate Saw Gummer;* Hosea O. Elmer, Mexico, New York, September 28.

"The nature of my invention consists in the combination of a cylindrical cutter, having a rotary motion, and placed on a frame having a reciprocating and rectilinear motion, with a jointed bed, within which the saw to be filed and gummed is clamped, by which combination both the under and inclined faces of the teeth are filed perfectly true, and the saw gummed and jointed."

Claim.—"I do not confine myself to any particular mode of doing this, viz: supporting the bed piece; nor do I confine myself to the particular mode of construction of the several parts as herein described, but any other method substantially the same, so long as the bed piece is jointed, and one part capable of being clamped, when in line, or at an angle with the other part; I do not claim the cylindrical cutter separately, as that has been previously used. But having thus described the nature of my invention and the manner in which it is operated, what I claim as new is, the employment or use of the cylindrical cutter, the said cutter having a rotary and also a reciprocating rectilinear motion, in combination with the jointed bed piece, in which the saw is placed, the cutter having the above motions communicated to it in the manner as described, or in any equivalent way, and the bed piece being constructed substantially as shown and described; by which combination, saws may be filed, gummed, and jointed, in an expeditious and proper manner, as set forth."

42. For an *Improvement in Piano Forte Action;* George Howe, Boston, Massachusetts, September 28.

Claim.—"Having described my improvement in piano forte action, what I claim as my invention is, jointing the fly of the jack to the stem of the same, so as to constitute a lever, the short arm of which has to move but little distance before it strikes against the regulating button, for the purpose of preventing any noise or "slapping," as above set forth."

43. For an *Improvement in Throstle Spinning Machines;* Charles H. Hunt, Lawrence, Massachusetts, September 28.

Claim.—"What I claim as my invention is, the escapement wheel, O, its escapement lever, (composed of the arm, *h*, and pallets, *i k*,) and stud, *y*, in combination with the reciprocating rotary mechanism, composed of the wheel, P, its concentric and endless grooves, row of pins, the pinion, *p*, and pendulous bar or arm, *r*; the whole being applied to give motion to the shaft, N, its pinion, the gear of the shaft, K, and the said shaft, K, in order to effect the movements of the spindle rail or rails, essentially as above specified."

44. For an *Improvement in Saw Mills;* Hazard Knowles, City of New York, September 28.

Claim.—"Having fully described my improvements in saw mills, what I claim therein as new is, the adjustable ways of the saw gate, when they are connected with each other in such manner, that they can be simultaneously and uniformly raised and adjusted in their positions, whilst the saw gate is in motion, for the purpose of varying the amount of the cutting action of the saw, substantially as herein set forth.

"I also claim the connecting and arranging of the feeding apparatus with the saw gate, and the adjustable ways thereof, in such a manner, that the feeding motion communicated to the material operated upon, will invariably be in perfect harmony with the cut of the saw, and also in such a manner as will enable me to ease the action of the saw, when passing through knots, and at any time adapt it to the nature and the depth of the material operated upon, substantially as herein set forth."

45. For an *Improvement in Brick Kilns;* Richard E. Schroeder, Rochester, New York, September 28.

Claim.—"Having fully described the construction and operation of my improved kiln, in the several processes of burning brick, I would state that I do not claim constructing a stationary kiln of masonry; but what I do claim as my invention is, so arranging the several compartments of the kiln, each provided with a fire place, in a circuit, and connecting them with each other and with the fire places and chimnies, by means of flues and dampers, that one compartment after another may be charged with fresh brick, and the brick be successively dried and heated by the waste heat, burned, cooled down, and removed, substantially as in the manner herein fully set forth."

46. For an *Improvement in Lath Machines;* Henry C. Smith, Cleveland, Ohio, September 28.

"The nature of my invention consists in turning the log or bolt from which the laths are to be cut, by means of poppet heads or wheels, arranged and operated at each end of said log or bolt, and driven by the same first moving power, or so as to have the same relative velocities, by which means all wrenching or twisting of the log upon its centre is entirely obviated, and it is firmly held up to the knives to be operated on it; and also in combining therewith the detachable dogs and hollow mandrel, for the purpose of clutching or releasing the log or bolt, and for centreing said bolt before it is placed upon the mandrels."

Claim.—"Having thus fully described the nature of my invention, what I claim therein as new is, the combination of the method of rotating the log or bolt from which the laths are to be cut, by means of the poppet wheels, arranged respectively on the shafts, and forms a part of the mandrel at each end of the log, and the gear wheels, or their equivalents, moving with equal velocities, so as to prevent any wrenching or twisting of the log on its centres, and to hold it firmly up to the knives whilst being operated upon by them, and the method of clutching and releasing the log, by means of the dog, hollow bearing for containing the clutch head, and hollow shaft for receiving the rod, which screws into said clutch, and by which the dog may be driven into the log, or the log released; the whole being arranged and operating substantially in the manner and for the purpose set forth."

47. For an *Improvement in Sounding Boards of Piano Fortes, &c.;* Alfred Speer and Ernest Marx, Aquackanock, New Jersey, September 28.

Claim.—"What we claim as our invention is, making the sounding board of a piano forte, or other stringed musical instrument, and arranging the strings and all appendages thereto, in the form of a cylinder, or part of a cylinder, or in any of the forms we have mentioned, as considered to be equivalent; the said board having its ends secured between two disks or heads, and having no other support, except that derived from the said disks or heads."

48. For *Improved Machinery for Forming Sheet Metal Tubes;* Orson W. Stow, Southington, Connecticut, September 28.

Claim.—"I do not claim the manner of forming tubes by means of a rod and concave bed, irrespective of the manner of operating the rod, for they have been previously employed, the rod being operated or driven in the bed, by means of a mallet or hammer, operated by hand, or by means of levers or cranks moved by gearing. What I claim, therefore, as my invention is, 1st, The method of mounting and operating the rod within the concave bed, in the manner as shown and described, viz: the ends of the rod being attached to the slide rods, and slide rods passing through the vertical guides, and having spiral springs around them, the lower ends of the slide rods being attached to levers, by operating which the rod is forced within the concave bed, and the lower portion of the tube formed.

"2d, I claim the hinged folders attached to the wings, which are hung on points, said points being in line longitudinally with the centre of the rod, and operated in the manner and for the purpose of forming the upper or remaining portion of the tube, as herein set forth."

49. For an *Improvement in Registers for Omnibuses and for other purposes;* J. Z. A. Wagner, Philadelphia, Pennsylvania, September 28.

Claim.—"What I claim as my invention is, fitting toll passages with a registering step, combined with mechanism, in such manner, that the aggregate number of full and fractional tolls due from passengers will be reduced to the denomination of full tolls, and registered, whatever the proportions may be in which the aggregate is composed of fractional and full tolls, substantially as herein set forth."

50. For an *Improvement in Bellows for Reed Instruments;* Isaac T. Packard, Campello, Massachusetts, September 28.

Claim.—"What I claim as my invention is, the employment in all reed instruments of bellows, having two chambers, in one of which a vacuum is produced, and in the other air is compressed, the said chamber being on opposite sides of the reeds, and communicating with each other through the reeds, so that when one forces air through them, the other, by the vacuum, draws it through at the same time; this I claim without reference to the precise construction of the bellows, or the mode of operating them."

51. For an *Improvement in Electro-Magnetic Engines;* John S. Gustin, Trenton, New Jersey, September 28.

"The nature of my invention consists in the arrangement of a pump and electro-magnets attached to a lever or working beam, with the several parts so adjusted with spring and pendulum, that by the application of a galvanic battery the pump is put in motion, and continues its work steady, without requiring the aid of personal attention, except that which is necessary to replenish the acids in the battery when exhausted."

Claim.—"What I claim as my invention is, the application of a spring or springs, or their mechanical equivalent, used as recipients of the excess of power in the closing of the electro-magnets and armature, to be imparted again to the next, as described and set forth."

52. For an *Improvement in Machines for Polishing Leather;* John M. Poole, Assignor to J. Pusey and James Scott, Wilmington, Delaware, September 28.

Claim.—"What I claim as my invention is, 1st, connecting or fastening the stand or stands that hold the polishers or burnishers to a belt, so as to traverse them in ways or grooves, or under a plane, substantially as described."

DESIGNS FOR SEPTEMBER, 1852.

1. For a *Design for a Medallion of General Scott;* Peter Stephenson, Boston, Massachusetts, September 7.

Claim.—"What I claim is, the design of a medallion of Winfield Scott, as represented in the drawings above referred to."

2. For a *Design for a Medallion of Franklin Pierce;* Peter Stephenson, Boston, Massachusetts, September 7.

Claim.—"What I claim is, the design of a medallion of Franklin Pierce, as represented in the drawings above referred to."

3. For a *Design for a Coal Stove;* William L. Sanderson, Troy, Assignor to R. Finch, Sr., and Reuben R. Finch, Jr., Peekskill, New York, September 7.

Claim.—"What I claim as my invention is, the within described design, configuration, and general arrangement of the forms, ornaments, and mouldings upon the stove as a whole, and upon the following parts individually: the side, back, and front plates; doors; bottom plate; top plate and cover; feet; water vase; cover and front of ash pit; the whole being shown in the accompanying drawings."

4. For a *Design for a Cooking Stove;* Samuel D. Vose, Albany, New York, September 14; ante-dated March 14, 1852.

Claim.—"I do not claim any detailed part of the mouldings or configuration. What I claim as my invention is, the general combination of the several mouldings and ornaments, as arranged together, the whole forming an ornamental cooking stove, as herein set forth and described."

5. For a *Design for a Parlor Stove;* Conrad Harris and Paul W. Zoiner, Cincinnati, Ohio, September 14.

Claim.—"What we claim as our invention is, the combination of the scrolls and foliage, arranged as set forth in the annexed drawing, so as to form an ornamental design for parlor stoves; to be known and called the Cottage Franklin."

6. For a *Design for a Cook Stove;* Samuel D. Vose, Albany, New York, September 14.

Claim.—"I do not claim any detailed part of the mouldings or configuration. What I claim as my invention is, the general combination of the several mouldings and ornaments, as arranged together, the whole forming an ornamental air-tight cook stove, as herein set forth and described."

7. For a *Design for a Cook Stove;* N. S. Vedder, Troy, New York, September 14.

Claim.—"What I claim as new is, the ornamental design and configuration of cook stove, the same as herein described and represented in the annexed drawing."

8. For a *Design for a Parlor Stove;* James J. Dulley, Assignor to Johnson, Cox, and Fuller, Troy, New York, September 14.

Claim.—"What I claim as new is, the ornamental design and configuration of stove plates, the same as herein described and represented in the annexed drawings."

9. For a *Design for a Camera Stand;* W. A. Allen, City of New York, September 21.

Claim.—"What I claim is, the design and configuration of the several ornaments, forming in combination an ornamental stand for cameras and other purposes, as described and set forth."

10. For a *Design for a Wire Fence;* Francis Kilburn, Lancaster, Pennsylvania, September 21.

Claim.—"What I claim as my invention is, the design of a wire fence, ornamented as herein described and shown in the accompanying drawings."

11. For a *Design for a Cooking Stove;* Orin W. Andrews, Providence, Rhode Island, Assignor to Isaac Backus, Canterbury, and John Pitt Barstow, Norwich, Connecticut, September 21.

Claim.—"What I claim is, the design and configuration as herein shown of the stove as a whole, and of the front, back, and side plates severally."

OCTOBER.

1. For an *Improvement in Grain Separaters;* Jacob Bergey, Wadsworth, Ohio, October 5.

"The nature of my invention and improvement consists in the manner of sustaining the inclined revolving perforated cylinder, by anti-friction wheels, upon whose peripheries the cylinder turns, it being prevented from descending below its required level by circular or ring projections, or flanches, secured to the exterior of the cylinder, and turning against the sides of the wheels, which themselves turn on short studs or axles inserted into the frame of the machine."

Claim.—"Now, I am aware that revolving screens, separately considered, are not new; also, that the conveyer, or endless apron, has been employed, in combination with a threshing cylinder, vibrating shoe and fan, and therefore, of themselves, I do not claim: but what I do claim as new is, the use of a hollow revolving cylinder, so constructed and so moved, as herein fully set forth, for the purpose of a straw carrier, by which the advantages above enumerated and explained are obtained."

2. For an *Improved Vice;* William Butler, Little Falls, New York, October 5.

Claim.—"What I claim as my invention is, the arrangement of the sliding bar with the screw attached thereto, with reference to the fast jaw, *a*, and the moving jaw, *b*, when said sliding bar is provided with a series of holes, or their equivalents, and said jaw, *b*, is provided with a pin, or its equivalents, whereby *b* can be set at varying distances with respect to *a*, and that distance afterwards regulated by the screw."

3. For an *Improvement in Hand Printing Presses;* Charles Foster, Cincinnati, Ohio, October 5.

Claim.—"Having described my improvements in printing presses, what I claim as new are, 1st, The arrangement, substantially as described, in a hand power press, of guide bars resting upon adjusting points, or hinged at their rear ends, and guided at their front ends to a vertical vibration, concentric with said points or hinges, so that the entire bed, guide bars and their appendages, shall move bodily upward upon giving the impression, and return by their own weight to the state of rest, whether operated by a shaft extending below the bed, and working a toggle joint beneath the bed or bars, as described, or in any equivalent way.

"2d, I claim, in connexion with the before described arrangement, the ascending grade at the fore end of the guide bars, for the purpose of limiting the range of the toggle at the period of giving the impression."

4. For an *Improvement in Seed Planters;* D. Haldeman, Morgantown, Virginia, October 5.

"The nature of my invention consists, 1st, in having the wheel or roller encompassed by one or more tyres, which may be adjusted to the wheel or to ler at pleasure, thus increasing or diminishing the diameter of the wheel, and allowing the seed to be planted the required distance apart, as will be hereafter shown."

Claim.—"Having thus described the nature and operation of my invention, what I claim as new is, the employment or use of the adjustable tyre or tyres, for the purpose of varying the diameter of the wheel, to allow the seed to be deposited the required distance apart."

5. For an *Improvement in Rotary Stove Grates;* Alexander Harrison, Philadelphia, Pennsylvania, October 5.

Claim.—"What I claim as my invention is, 1st, The combination of the rotary movement of the bottom grate with the vertical annular grating, or its equivalent, surrounding the same, for the purposes substantially as herein set forth.

"2d, I claim the rotary movement of the bottom grate with the controlling tilting movement of the same, substantially as herein described.

"3d, I claim the combination and arrangement of the several parts, whereby the aforesaid rotary and tilting movements of the bottom grate are effected, substantially as herein described."

6. For an *Improvement in Seed Planters;* Robert M. Jackson, Penningtonville, Pennsylvania, October 5.

"The nature of my invention consists in applying a sieve to the machine, which will deposit the fine earth upon the grain, and throw the coarser parts to each side, and a marking rod, by which corn may be planted, to be in rows across as well as lengthwise."

Claim.—"What I claim as my invention is, the corn planter sieve and its appendages, for the purpose of sifting and depositing the fine earth upon the grain, and throwing off stones and such matter as would obstruct the young sprout in coming through the ground, substantially as described and illustrated herein."

7. For an *Improved Spark Arrester;* Volney P. and B. Kimball, Watertown, New York, October 5.

Claim.—"Having described the nature of our invention and the manner in which it is operated, what we claim as new is, the revolving screen, in combination with the chamber, the lower part of said chamber communicating with the smoke pipe at a point below the tops of the exhaust tubes, by which arrangement a downward draft is created within the chamber, and the cinders drawn from the screen as it revolves, thus preventing the clogging of the screen, as set forth."

8. For an *Improvement in Bee Hives;* Lorenzo L. Langstroth, Philadelphia, Pennsylvania, October 5.

Claim.—"What I claim as my invention is, 1st, The use of a shallow chamber, substantially as described, in combination with a perforated cover, for enlarging or diminishing at will the size and number of the spare honey receptacles.

"2d, The use of the movable frames, or their equivalents, substantially as described; also, their use in combination with the shallow chamber, with or without my arrangement for spare honey receptacles.

"3d, A divider, substantially as described, in combination with a movable cover, allowing the divider to be inserted from above between the ranges of the comb.

"4th, The use of the double glass sides in a single frame, substantially as and for the purposes set forth.

"5th, The construction of the trap for excluding moths and catching worms, so arranged as to increase or diminish, at will, the size of the entrance for bees, substantially in the manner and for the purposes set forth."

9. For an *Improvement in Upright Piano Fortes;* R. E. Letton, Quincy, Illinois, October 5.

Claim.—"What I claim as my invention is, 1st, extending the upper part of the metallic plate or cap, at the part where the shorter of the strings are placed over the sounding board, and supporting it by blocks or supports, which pass through the sounding board to the frame timbers, substantially as set forth, whereby the higher end of the bridge, or that part on which the strings of the higher notes rest, is allowed to be brought nearer to the centre of the sounding board, to get a better vibration.

"2d, The combination, in the manner substantially as described, of the cushioned block and the adjustable button on the upright wire attached to the key, for the purpose of preventing the entire descent of the hammer, after striking, until the key is left free."

10. For an *Improvement in Machines for Wringing Clothes;* Joseph P. Martin, Philadelphia, Pennsylvania, October 5.

Claim.—"Having fully described my invention, what I claim as new is, keeping the ends of the clothes sack distended, during the progress of wringing, to equalize the twisting of the same at all parts, by means of the elliptical spring leaves and elastic wings, substantially as described."

11. For an *Improved Apparatus for Puddling Iron, &c.;* James M'Carty, Reading, Pennsylvania, October 5.

Claim.—"Having described my automatic puddling apparatus, what I claim as new is, 1st, the combination of an automatic rable, with a revolving or moving basin, arranged and operated substantially as herein set forth, or with a stationary basin, or bottom, whereby much manual labor is dispensed with, for stirring the iron in the process of puddling.

"2d, The arrangement of the hollow shaft, cooler, and moving basin, in such manner that a stream of water can be kept circulating round the bottom and sides of the latter, to prevent it from being overheated, substantially as herein described.

"3d, The combination of the crank and swinging guides, or their equivalents, which enables the operator to make the rable stir over different parts of the bottom, and at different angles to the side of the furnace, and also to remove it out of the way when necessary."

12. For an *Improvement in Piano Fortes;* James and John McDonald, City of New York, October 5.

Claim.—"What we claim as our invention is, 1st, the combination of the wind chest and flute, or other similar wind pipes, with the horizontal piano forte action, in the manner substantially as set forth, to wit: the pipes being placed horizontally at the bottom of the case below the piano forte action, and the wind chest placed below the front ends of the piano forte keys, in such a manner as to allow the valves to be operated directly by the said keys.

"2d, The manner of opening the valves of the flute, or wind pipes, to play an octave lower than the piano, either at the same that they are being played at the same pitch as the piano, or not, by means of the series of levers arranged and operated upon by the blocks upon the vertical pins, under the piano key."

13. For an *Improvement in Printing Presses;* John G. Nicolay, Pittsfield, Illinois, October 5.

Claim.—"Having fully described my rotary cone printing press, what I claim as new is, not the use of conical impressing cylinders, but the peculiar arrangement and combination of conical impressing cylinders, one or more in number, each provided with a set of conical distributing inking rollers adapted thereto, and with a rotary wheel or disk, substantially as described.

"I also claim, in combination with the conical impressing cylinders, the position and arrangement of the clamp consisting of the metal plate, spring, and arm or lever, which retains the paper at the required angle to receive the impression, and release the same when the impression is taken, substantially as set forth."

14. For an *Improvement in Expanding Window Sashes;* Mighill Nutting, Portland, Maine, October 5; ante-dated June 16, 1852.

Claim.—"I am aware that window sashes, wide enough to fill the window frames for which they were designed, and which, therefore, could not be put in or taken out, without removing the stop strips, have had grooves made in their edges, to receive spring packing to make their joints tight.

"I am also aware that grooves have been made in window frames, and fitted with spring packing, to press against the edges of the sash, to make the joints tight.

"I am also aware that expanding window frames have been made, and the sashes fitted to them, in such manner, that the ordinary stop strip is not required, and that these frames expand to allow the sash to be taken out, and contract to hold the sash in place after it is reinstated.

"I am also aware that this mode of allowing the sash to be put in and taken out is objectionable, because of its cost and its inapplicability to windows of the common construction now in houses, which could not be modified so as to embrace it, without great inconvenience, damage to the plaster of the walls, &c.

"To none of the foregoing contrivances do I lay any claim; neither would I patent or use them, if I were the first who invented them, because of the superior simplicity, cheapness, and utility of the window described, in which I claim as my invention the sash, constructed in two pieces, so that both, when brought together, shall be narrower than the distance between the bottoms of the grooves in the jambs of the frame in which the sash is designed to be placed, by at least the thickness of one of the stop strips of the frame, and connecting these two pieces of the sash in such manner that one will slide past or into the other, so that the sash can be contracted or expanded, as may be required, to make it fit different window frames, and to adapt itself to the varying width of the same

frame, and also to admit of its being put into and taken out of the frame, without removing the stop strips therefrom; the two parts of the sash thus moving towards and from each other, having springs, or the equivalent thereof, adapted to them, so as to give them a constant tendency to diverge from each other, that the sash may at all times expand promptly, and fill the frame, to hold itself firmly in place, substantially as herein described."

15. For an *Improvement in Milling Machines;* William H. Robertson, Hartford, Connecticut, October 5.

Claim.—"What I claim as my invention is, the construction and combination of the vertically moving cutter stock, or poppet head, with the driving pulleys, &c., mounted on a swinging frame, hung with a pivot hinge at the bottom, the connexion between the two being effected by radius rods, in the manner and for the purpose substantially as herein set forth and described."

16. For an *Improvement in Method of Priming Fire Arms;* Christian Sharps, Hartford, Connecticut, October 5; patented in England, April 22, 1852.

Claim.—"What I claim as my invention is, the priming of fire arms, by throwing a pellet of percussion or priming material over the nipple, at the time the cock is descending thereon, so that the priming shall be struck down in its flight between the cock and the nipple, and exploded."

17. For an *Improvement in Window Frames;* Henry Clay Smith, Portland, Maine, October 5.

Claim.—"What I claim as my improvement is, the pulley style, constructed of the pieces as set forth, in combination with the springs, by which means I am enabled to make use of solid or immovable bead strips and bands, and to remove the sash at pleasure from the frame, in the manner substantially as described."

18. For an *Improvement in Time Pieces;* Silas B. Terry, Plymouth, Connecticut, October 5.

Claim.—"What I claim as my invention is, 1st, hanging the balance of a clock or time piece on a spring or strip of metal, which is fixed, or prevented from turning, at both of its ends, but capable of twisting between the ends, substantially as and for the purpose herein described.

"2d, Making one part of the fork or crutch wire flat and thin, substantially as shown at *k*, or otherwise constructing it, to allow it to bend or move in a similar manner, and connecting the said fork or crutch wire with the balance, in any manner, as shown at *i*, which causes it to give its impulse in the same direction as the motion of the balance, the said bending or motion of the fork or crutch, being for the purpose of allowing it to transmit the impulse in the above direction."

19. For an *Improvement in Churns;* Lucian A. Brown and Hubbard Bigelow, Assignors to Henry K. W. Welch, Hartford, Connecticut, October 5.

"The nature of our invention consists in the construction of the churn, in such a manner as to increase the agitation of the cream to be converted into butter, and the adaptation of the churn for "working" the butter after being made, or in other words, extracting the butter-milk and watery parts extant in butter, thereby rendering it more compact and 'firm,' and less liable to become 'rancid.' "

Claim.—"Having thus described our apparatus and its operation, what we claim as our improvement and invention is, the combination of the tub, including the appendages described, with the frame and stands, or any other convenient frame work adapted to the use of the tub, in a vertical and horizontal position, but in manner and for the purposes substantially as herein set forth and described."

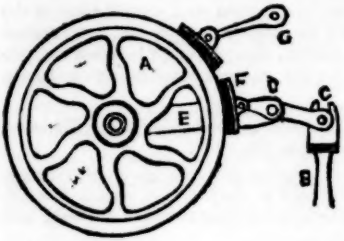
MECHANICS, PHYSICS, AND CHEMISTRY.

*Infinitesimal Taking-up Motion for Power Looms.**

Under a recently specified patent for the improved "manufacture of textile fabrics," Mr. Harrison, the well known machine maker of Black-

* From the London Practical Mechanic's Journal, July, 1852.

burn, has described a new "taking-up motion," which has often occurred to ourselves as a most desirable plan for the purpose. Instead of the common ratchet wheel and catches, a small drum or pulley, having its periphery roughened by diamond lines, is used, this drum being actuated by a duplex lever and friction block, on the principle of the friction windlass movements for ships. Our figure represents the apparatus in side elevation. A is the friction pulley, to be driven by the vibration of the rod, B, in any convenient way. This rod is jointed at C, to a short double lever working on a centre at D, in the end of a longer lever, E, which oscillates freely on the stud-centre of the pulley, A. The opposite end of the lever, C, D, has jointed to it a segmental block, F, faced with leather, to work against the pulley's roughened surface. At G is a fixed centre, to which is hinged a detent lever, having a joint friction block like that just described.



As the rod, B, rises, it is easy to see that the species of knee-joint action of the lever, C, D, will cause its friction block to press firmly on the pulley, which is thus carried round as far as the traverse of the rod, B, permits. During this action, the detent lever, G, being set at an angle with a radial line from G to the pulley centre—the reverse of that of the lever, C, D—will allow its block to slip like the back action of an ordinary ratchet detent. As the rod, B, descends for a second stroke, its lever block slips back, whilst that of the detent, G, holds. By the adoption of this movement, the increments of movement of the pulley, A, are not governed by any definite measure, as in the ratchet teeth of the common wheel; and therefore, whatever minute changes are made in the traverse of the rod, B, such change will be accurately conveyed to the pulley, A.

Mr. Macdowall, of Johnstone, has proposed a contrivance of a similar nature for obtaining a silent and minutely adjustable feed for the timber carriage of saw mills. In this, as well as our own adaptation of it to power looms, the pulley is made perfectly smooth, the friction blocks having smooth segmental metal surfaces; for it appears to us that the elastic cushion must, to a certain extent, defeat the great point of the invention—the direct conveyance of the minute changes in the vibratory movement of the driver.

Mr. Harrison effects the required variation in the driver by the increase of the diameter of the cloth beam, in a manner very similar to that adopted by Mr. Milligan. He has also so modified the common ratchet movement, that it is capable of effecting very minute increments of take-up. He does this somewhat on the principle of the "stepped" spur wheel, by using, say 7 catches hung on one centre, and placed parallel to each other, and increasing in length from 1 to 7 by regular gradations, the distance from the end of the first to the end of the seventh being equal to the pitch of the ratchet wheel, which they actuate. By this means the ratchet wheel may be moved to so slight an extent as one-seventh of a tooth, as each tooth is acted on by each individual catch in succession. Precisely

the same effect is produced by using a "stepped" ratchet wheel, that is, a wheel with several sets of teeth arranged obliquely, or in steps across its periphery, as in the wheel and pinion arrangements of screw steamers, one broad catch only being capable of working the whole series.

Hints on the Principles which should regulate the Forms of Boats and Ships; derived from original Experiments. By Mr. William Bland, *of Sittingbourne, Kent.*†

Continued from page 277.

Chapter XIII.

Having completed some of the most necessary experiments relative to ships, as a supply of materials for the foundation of the superstructure, a brief recapitulation of the conclusions, before entering upon the construction of a boat or ship upon the principles proved essential to be observed, will, it is considered, simplify proceedings, and therefore be next entered upon.

Of the Resistance of Water against the Head of a Vessel.—With a square and perpendicular bow, the resistance is directly as the surface.

Of Weight—its Effects when placed in a body floating on Water.—The resistance of water against any increase of weight is directly as the weight.

Of Lateral Resistance.—The centre of lateral resistance is exactly at the mid-length point of the keel of a ship when floating level, and at rest; but not otherwise: for when in motion, the head or bow meeting with greater resistance from the water than any other parts, the centre of lateral resistance will be moved proportionately forward.

Stability.—This acts when the width is increased one-half, or nearly the cubic ratio; but not afterwards, being as 2, 7, 14, 22. And when the length is added to, the law of stability, if the dimensions be doubled, operates in the proportion of 1 : 3; then, the same quantity of length being continually annexed, it takes the arithmetic ratio. Again, the height or thickness of a body being alone varied, the law of stability operates most when the depth, measured from the line of flotation on the parallel-sided body, equals one-fifth of the width, the centre of its gravity being on a level with the surface of the water.

The Form of the Bows.—The conclusions are, that the sharper the form of the bows, the less is the resistance from water; and if gentle horizontal curves be substituted for horizontal straight lines on the sides of the bows, the speed will be improved.

The Bevelling-up of the Bows.—The effects of the bevelling-up of the bows are in favor of speed by diminishing resistance.

The Bevelling-up of the Stern.—The tapering of the sides throughout the greater length of the body of a ship is detrimental to speed; but if it be commenced at the midship section, and the reduction moderate and a curve, the advantage will be great. The same benefit results when the bottom is gently curved up from the midship to the bows; and, indeed, the effect exceeds that towards the stern.

† From the London Civil Engineer and Architect's Journal, October, 1851.

Of the Length of Ships, all having the same Bows and Beam, and equal in Weight.—The result obtained is, if equal increment of length be tested, equal advantages will be obtained on the side of the equal increments.

The Form of the Midship Section.—As regards speed, the semi-circular form possesses the most, and the triangular one the least. Again, the flat bottom floats the shallowest, and the triangle the deepest, being double that of the former when of equal weight.

Lee-Way.—This property in a ship depends directly upon its perpendicular depth and length at which it is immersed whilst floating upon the water.

Of Floating Bodies Varied in their Dimensions.—It appears that the shallower the same weight can be supported upon water, the less the resistance as regards speed; consequently, extended surface of bearing to a certain degree is advantageous towards facilitating progress, and which a moderate curve always imparts. But where an extension of surface-bearing can be obtained without loss of speed, stability becomes directly increased, which is a gain in power to vessels impelled forward by the wind, as it admits of a proportionate increase in the breadth of sail, therefore of speed.

Whilst carrying out these particular experiments, it appeared, if the angles exposed in any way to the water were rounded off, greater speed ensued; but it was generally at the expense of stability, and decidedly so if the pro-sections be low, because the greater is the length of lever from the centre of motion.

Curves were found to favor speed in comparison with straight lines; consequently, the latter are to be avoided as much as possible wherever speed is the object, and the oar and steam are to be the moving powers.

With respect to the general form of ships, experiment decides most positively that the bird or duck species affords the true models for comparison and study, since the forms of fish are so exceedingly various.

Chapter XIV.

Much has been said upon the comparative speed of several models, likewise of their stability. Now, as stability forms the basis of the power by which the wind, acting upon sails, impels forward the body of a vessel, it will be right to take into consideration and calculation these respective qualifications, as possessed by some few of the models which have been tested. Before doing so, however, since it is evident that those models which equalled or surpassed their competitors in speed, and at the same time had greater stability, will always, under the same weight, run away from vessels of less stability; and if admitted, it will be necessary only to investigate the more extreme cases of both speed and stability, with the exception of one or two instances, when the merits of all the rest follow as a matter of course.

From what has been already ascertained, it appears that when two models of equal weight and similar outline, but one longer than the other, the former invariably had the advantage in speed: consequently, in the following investigations, the calculations had best be confined to models of the same length, but varying in their dimensions of breadth; their weights when tested against each other being always made equal.

Since the models of 28 inches in length are the largest which have been employed, and from their variety of form, though only few in number, they may in fairness be selected for the requisite calculations.

First.—Let the model I, in experiment 72, be selected, which is of the bird or wild fowl. shape, 4 inches wide and 28 inches long. This, when tested with the model O, in experiment 79, also of the bird form, whose breadth is 5¾ inches, length 28 inches, and the weight 2 lb. 5 oz., gave the following result: the model I, beat in speed the model O, by 12 oz. extra weight. The stability of I, equalled 2½ oz., and that of O, 8 oz.

Now the 12 oz. extra weight may be called one-third of the whole weight moved, being 2 lb. 5 oz. The stability of O, which represents the power of carrying sail, is superior to that of I, in the proportion of 32 : 10, or 3 : 1; therefore say two, which is 74 ounces over and above the model I. This sum is to be set against the one-third of the extra weight of 12 oz., or speed of I, and gives the balance of speed, the sails of each being proportional to their respective stabilities, greatly on the side of O, and equal in ounces to 74—12, or 62 ounces.

The draft in the water of these models, each laden with the extra 12 oz., making 49 oz., was in the model I, 1⅛-inch deep; and in O, ¾-inch; thus proving the boat with greater breadth of beam would, under canvas, be decidedly the best boat of the two.

Second.—The next models for comparison are O and P, in experiment 80. These were both 5¾ inches wide, 28 inches long, and each of the weight of 3 lb. 4 oz. In this instance, O proved superior in speed to P by 2 lb. 5 oz. extra weight. The stability of O now equalled 8½ oz., and that of P 12 oz. The extra weight of 37 oz. equalled, say two-thirds of the weight moved.

The stability of P is not quite one-half more than that of O, but let it be so, which sum, if denoted by ounces, will equal 26 oz., and this set against the 37 oz., the extra speed of weight of O, will give the superior speed. When both are placed under sails proportionate to their respective stabilities to the model O, and in ounces equal to 37—26 = 11 oz., meaning when P and O are moving under sail with their speeds equal, O will carry at the same time 11 ounces more than P.

The draft in the water of these two models, when of equal weight, and each having the extra 37 oz., or total of 74 oz., was in O 1 1/16-inch, and in P ⅞-inch.

Third.—The model P again made use of to test the model Q, in experiment 81. The dimensions, &c., of P are, width 5¾ inches, length 28 inches, weight made equal to 3 lb. 4 oz. The dimensions of Q are, width 8 inches, length 28 inches, weight 3 lb. 4 oz. The result, as stated in experiment 82, was 20 ounces, which P carried extra to cause its speed to be equal with the model Q. The stability of P equalled 12 oz., and that of Q 21 oz. The extra weight of 20 oz. is two-fifths of 52 oz., the weight of the model. The stability of Q is just one and three-quarters of P, or above that of P by three-fourths of 52, which when reduced to ounces, will be 39, and set against the two-fifths of the extra weight or 20 oz., will give the balance of speed on the side of Q, equal to 19 oz.

These two models, P and Q, sank in the water when each was loaded with the additional weight of 20 oz., or total 72 oz.,—viz: P $\frac{7}{8}$-inch, and Q 1 inch.

The conclusion arrived at is, the superior stability of Q enables it to have the advantage in speed over P, each carrying sail proportionate to their stabilities.

Fourth.—From the marked speed of G over P, it will be right to compare its qualities with those exhibited in Q. It has been already shown that the speed of O beat the speed of P by 37 oz.; and P beat Q by 20 oz.; therefore, it will require the sum of the two, or 37+20=57 oz. extra weight placed in O to retard its speed till it equals that of Q. The weight of each, as before given, equalled 52 oz.; therefore, the extra weight of 57 oz. exceeds it by 5 oz. The stability of O equalled 8½ ounces, and that of Q 21 oz., without the 57 oz. extra. From the above it appears that O has the advantage in speed equal to more than the weight moved; and Q has the excess of stability above O equal to one and a-half its stability; which being reckoned in ounces equals 52+52—3 oz., the deficiency=75 oz.; but the extra weight of 57 ounces when taken from 101 oz., leaves 18 oz. in favor of Q, the model with the greatest breadth of beam.

The depth or draft in the water of the models when under the double extra weight of 37+20, or 57 oz., making the total weight of each 109 oz., was in model O, 1⅝-inch, and in Q, 1⅛-inch. The model Q, from its great breadth of beam, would beat the model O, provided, as before mentioned in the preceding cases, the surface of the canvas be proportionate to their stabilities.

Fifth.—In experiment 82, the model Q was tested against R. The dimensions of Q are 8 inches in width, 28 inches long, and the weight 5lb. 1 oz.; and those of R, 11 inches wide, 28 inches long, and weight, 5lb. 1 oz., also. Likewise, it is there shown the model Q beat in speed the model R, by 4 oz. extra weight. The stability of Q equalled 24 oz., and that of R 29 oz.

The extra weight of 4 oz. is one-twentieth of 81 oz., and the stability of R exceeded that of Q by 5 oz., which is rather more than one-fifth of 24; and, estimated in ounces, will, in 81 oz., the weight moved, equal 16 oz.; and, minus the 4 oz. extra weight, the measure of the superior speed of Q, leave 12 oz. as the advantage, ultimately, of R over Q. Admitting the above to be correct, then R, under sail, and of equal weight with Q, will beat that, or any other of the same length, but having the beam of less dimensions. The two models, Q and R, sank in the water $\frac{7}{8}$-inch when of the same weight and with the addition of the 4 oz. extra, or total 85 oz.

Sixth.—In experiment 83, the model Q was tested against T, the dimensions of these two boats being the same in width, length, and weight. The result of their speeds is also denoted—that T beat Q by 32 oz. The stability of T equalled 16 oz., and that of Q 23 oz.

Therefore, Q has more stability than T, by nearly one-half, being 7 oz., which, if put in ounces, equals 30½ oz. But the extra speed of T was 32 oz.; and, taking 30½ oz., or 32—30½, leaves the sum of 1½ oz. on the side of T, which would in consequence, under equal weight and sails

proportionate to their stabilities, beat Q by the said extra weight of 1½ oz. The models Q and T sank into the water when of the same weight, thus: Q sank $\frac{1}{16}$-inch, and T sank $1\frac{1}{16}$-inch.

The inference which may be drawn from these calculations is, that Q, if lengthened, would beat R; and R, if made longer than Q, would again beat Q. Moreover, if a model, say S, be made of the same proportional length and breadth of R, before lengthened, meaning the breadth at the midship to be two-fifths of the length, but the length of S to equal the length of R, increased, the breadth of S will then exceed the breadth of R, whose length alone had been added to, and therefore would be beaten by S.

Chapter XV.

It has been seen in the investigations of the preceding chapter, that when any two of these models were of equal weight and equal length, the one with the greatest breadth of beam beat the other. In the experiments on stability numbered 8, and scale C, it is shown when the thickness or depth of flotation is varied, the breadth and length being preserved constant, the greatest stability exists at one-fifth of the beam.

Now, it has been before mentioned in the last chapter relative to the depths of the lines of flotation, that in some instances, as in experiment 80, in I, it exceeded the one-fifth; and in others, as in experiments 81, 82, it was less. Upon testing a few of the models between one-fifth and one-fourth for the line of flotation, the following proved to be the case.

Now, with the models I and O, each having their lines of flotation situated between the one-fifth and one-fourth, which in the model I equals $\frac{3}{8}$-inch, and in O equals $1\frac{3}{8}$-inch, at this depth, the weight of I was required to be increased until it altogether equalled 39½ oz.; and model O equalled 78 oz.

In the experiment No. 80, the models I and O, being then of equal weight, the speed of I beat the speed of O by 21 oz. Under the present circumstances, O exceeds the weight of I by 39 oz.; therefore I has the advantage over O of 21 oz. and 39 oz., or together 60 oz. With respect to the stability possessed by these two models, I and O, it was found upon trial that I in stability equalled 2½ oz.; and O equalled 8½ oz., showing O to have 6 oz., or two stabilities above I, which in weight equals 78 oz.; but take away the 60 oz., and there remains 18 oz. in favor of the model O, when under sail.

Likewise, in the same chapter, it is stated of the models O and Q, that when of equal weight, O beat Q by 64 oz. extra weight. Upon causing the model O to sink in the water until its load line was between one-fifth and one-fourth, it required an increase of its weight, as before given, up to 78 oz.; and Q to equal 152 oz. The stability which each now possessed, was in O 8½ oz., and Q 32 oz.—that is to say, the model Q possesses (let it be granted) two and a-half stabilities above the model O, or in ounces $78+78+39=195$. However, from this sum must be taken the extra weight of Q above O, which is 74 oz., together with the 64 oz. the extra weight in speed, and equalling 138 oz.; or 195—138

=57 oz., which number of ounces is on the side of Q, when under sail proportionate to its stability.

Again, with regard to the models Q and R, that when of equal weight Q beat R in speed by 4 oz. extra weight. It has been mentioned before of the model Q, when the line of flotation was made one-fifth and one-fourth of the beam, that it required the whole weight to be 152 oz. The model R to be similarly circumstanced, required its whole weight to amount to 292 oz.; and the stabilities of these two models was in Q, equal to 32 oz.; and in R 42 oz.; therefore, in the present instance, R has one-third of a stability above Q, which in ounces equals 152÷3=50; but from this sum the extra weight of R above Q must be deducted. Now the weight of R equals 292 oz., and that of Q 152; then 292—152 equals 140 oz., which, with the 4 oz. representing the speed of Q above R, comes to 144 oz. The superior stability of R has been shown to be 50 oz.; therefore, 144—50=94 oz., by which Q beat R in speed.

From the above result it is clear that for the model R to beat in speed the model Q, it will be necessary to place the line of flotation considerably lower than one-fifth, so as to materially lighten the whole weight of R. But upon taking out 96 oz. from R, thus leaving 196 out of 292 oz., the stability of Q, as before, equals 32 oz.; and that of R equals 34 oz.; and R sank in the water with the reduced weight down to $1\frac{1}{8}$-inch, and Q also to $1\frac{1}{8}$-inch. The difference in the present stabilities is 2 oz. for R, which in ounces=152÷32=$4\frac{2}{3}$ for each ounce; and, therefore, the 2 oz. of greater stability=9 oz.; and being taken from 196, or 196—9=187, and 187—152=35 oz. of speed against R.

Again, after lightening the model R until it equalled in its whole weight 152 oz., the same as the model Q, the stability of R was now tried, and found to equal 32 oz., equalling that of Q; and R sank only to $1\frac{3}{8}$-inch.

It has been previously mentioned Q beat R in speed when they were of the same weight, by 4 oz.; consequently, their stabilities being now the same, Q will, under sail, again beat R. Before, however, the result was quite contrary, as R by its superior stability beat Q. This being the case, it then appears for R again to beat Q, more weight must be removed out of R; that is to say, until it is of the same precise weight as it was, as in experiment 83, namely, 81 oz. instead of 152 oz.

When the models Q and T were made to sink down into the water to the depth of between one-fourth and one-fifth of their midship breadth, the weight was required to be increased till it amounted in the total of the model Q, as before given, to=152 oz.; and that of T to=140 oz.

In consequence of the above additional weight, the stability of T equalled 18 oz.; and that of Q 32 oz.

It appears, then, from these stabilities, that the model Q has the advantage over T to the amount of three-fourths of a stability, and which, if put into ounces, equals 105, the stability and weight of T. Q exceeds T in weight by 152—140=12 oz.; but the extra speed of T over Q=32 oz., which sum must be deducted also; then Q beats T in speed, when both are under sail, by the number of 105—12—32=61 oz.

I.—TABLE *of the difference of the Speed between the six Models when Towed through the Water.*

Model.	Shape.	Beam.	Weight.	Result.
		INCHES.	OUNCES.	
I	Bird.	4	37	O beaten by 21 ounces.
O	Bird.	5¾	37	
O	Bird.	5¾	52	P beaten by 27 ounces.
P	Oblong.	5¾	52	
P	Oblong.	5¾	52	Q beaten by 20 ounces.
Q	Oblong.	8	52	
O	Bird.	5¾	52	Q beaten by 64 ounces.
Q	Oblong.	8	52	
Q	Oblong.	8	81	R beaten by 4 ounces.
R	Bird.	11	81	
Q	Oblong.	8	70	Q beaten by 32 ounces.
T	Bird.	8	70	

I is the swiftest, O the second, T the third—all of the bird shape.

II.—TABLE *of the difference of Speed between the six Models when considered under Sail proportional to their Stabilities, and carrying a light Load.*

Model.	Shape.	Beam.	Weight.	Depth.	Stability.	Result.
		INCHES.	OUNCES.	INCHES.	OUNCES.	
I	Bird.	4	37	0 15-16	2½	I beaten by 62 ounces.
O	Bird.	5¾	37	0 11-16	8	
O	Bird.	5¾	52	0 15-16	8½	P beaten by 11 ounces.
P	Oblong.	5¾	52	0 6-8	12	
P	Oblong.	5¾	52	0 6-8	12	P beaten by 19 ounces.
Q	Oblong.	8	52	0 5-8	21	
O	Bird.	5¾	52	0 15-16	8½	O beaten by 8 ounces.
Q	Oblong.	8	52	0 5-8	21	
Q	Oblong.	8	81	0 7-8	24	Q beaten by 12 ounces.
R	Bird.	11	81	0 13-16	29	
Q	Oblong.	8	70	0 13-16	23	Q beaten by 1½ ounces.
T	Bird.	8	70	0 7-8	16	

The model R is the swiftest under sail with the light load, T the second, and Q the third—Q being of oblong form, R and T of the bird shape.

III.—TABLE *of the difference of Speed between the Models when supposed to be under Sail proportionate to their Stabilities, and so Loaded as to draw between one-fourth and one-fifth of their Beams deep in the Water.*

Model.	Shape.	Beam.	Weight.	Depth.	Stability.	Result.
		INCHES.	OUNCES.	INCHES.	OUNCES.	
I	Bird.	4	39½	0 7-8	2½	I beaten by 18 ounces.
O	Bird.	5¾	78	1 3-8	8½	
O	Bird.	5¾	78	1 3-8	8½	O beaten by 57 ounces.
Q	Oblong.	8	152	1 13-16	32	
Q	Oblong.	8	152	1 13-16	32	R beaten by 94 ounces.
R	Bird.	11	292	2 1-2	42	
Q	Oblong.	8	152	1 13-16	32	R beaten by 35 ounces.
R	Bird.	11	196	1 5-8	34	
Q	Oblong.	8	152	1 13-16	32	T beaten by 61 ounces.
T	Bird.	8	140	1 13-16	18	
O	Bird.	5¾	78	1 3-8	8½	P beaten by 6 ounces.
P	Oblong.	5¾	84	1 3-8	12	

The model Q is the swiftest under sail, when full loaded, and T the second—the oblong, in this instance, being the best.

IV.—TABLE *showing the proportion of the Beam the depth of flotation ought to be for the greater Speed, with bottoms quite flat, and impelled forward by the Wind on Sails proportioned to their Stability.*

Model.	Shape.	Beam.	Weight.	Depth.	Stability.	Proportion of depth to the beam.	Proportion of breadth to the length.
		INCHES.	OUNCES.	INCHES.	OUNCES.		
O	Bird.	5⅜	50	0 7-8	8½	One-seventh	5
Q	Oblong.	8	152	1 13-16	32	One-fourth.	3½
R	Bird.	11	81	0 13-16	29	One-fourt'h.	2½
T	Bird.	8	70	0 7-8	16	One-ninth.	3½
I	Bird.	4	20	0 9-16	2½	One-seventh	7

Upon a review of these tables, it will be seen that a maximum of weight and speed is incident to some form of the models, and not to others. This circumstance is most apparent in the long bird or fish shapes, since their stabilities cease to increase with additional weight, after it amounts to a certain quantity; that quantity, therefore, may be denominated the limit or maximum. But with the oblong model Q, and the duck shape model R, any increase of their weight is attended with an increase of their stability also. However, it is seen of the model Q, that with the increased stability, consequent on the additional weight, the speed is not so retarded by it as the model R, and the other models; therefore, advantage can be taken of this peculiarity for all ships intended for burthen.

(To be Continued.)

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*Casting in Bronze.**

On Saturday last we spent some hours at the foundry of Mr. Robinson, in Pimlico, for the purpose of being witnesses to the new process of casting in bronze, by which works of great size and importance are moulded entire, instead of piecemeal as of old. Every multiplication of the acts by which a work of Art is to be transferred from its original Art-language into another increases, it will be obvious, the risk of some sacrifice of the author's intentions or proportions; so that Mr. Robinson's new method, by which a single act of translation is made to suffice, is at once a simplification and a most valuable improvement. Our readers may remember that the first experiment on a large scale was made with Mr. Behnes's Peel statue for the town of Leeds,—and the success was such as to establish the process for future great works. In the present case, the subject was the fine statue, upwards of ten feet in height, which Mr. Baily has modelled for Sir Robert's native town, Bury, in Lancashire. Of old, the casting of large pieces, even when such works were divided, took place in pits dug to contain the mould,—and the legs and trunk would have received the burning stream which was to harden to immortality within them in upright posture. On the present occasion, a huge iron case, strongly bound and riveted, had been built on the surface of

* From the London Atheneum, July, 1852.

the floor, of dimensions to receive the full-length figure in a horizontal position. Close at hand glowed and roared the huge furnace in which the fusion of metals was, under the compelling power of a heat intensified into almost invisibility, for hours going on. When this process of fusion was accomplished, the mixed metal, to the weight of more than two tons, was received into an iron cauldron, and swung by machinery to the case which enshrined the mould. In the black sand that formed the roof of this case and of the mould there was one great vortex for the reception of the flaming material,—and from this, channels running in all directions to convey it horizontally to every part of the figure at once. Here, the liquid flame was skimmed; and after a few minutes of breathless pause, under the influence of strong excitement to ourselves, and of deep anxiety no doubt to those more immediately concerned—the final signal was given. The cauldron was turned over at the mouth of the vortex by the machinery from which it swung—and in thirty seconds by a stop-watch, the Bury 'Peel' was cast! The thing was like the creation of an enchantment. The workmen at once proceeded to the task of knocking away and uncovering; —and the result is, a cast of surpassing beauty—almost perfect from the mould itself—and scarcely needing the chaser's hand.

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*The Screw and Paddles Combined.** By J. Bourne, C. E.†

I am not aware that there are any vessels in actual existence which are propelled by the conjoint action of paddles and a screw, but some years ago I proposed the establishment of vessels of this kind, under circumstances which it will require a slight digression to recite.

The Peninsular Steam Packet Company, of which the Peninsular and Oriental Steam Packet Company is a subsequent extension, was established by my father, the late Captain Bourne, who advanced more than half the capital necessary for the establishment of the company himself, while the residue was chiefly contributed by his brothers and other members of his family. The *Tagus*, *Braganza*, and other original vessels of the company were constructed under my direction, and they were generally considered to the best vessels of their time; but for many years I have ceased to have any further connexion with the company than is implied in an interest in its success, and a desire to see it prosper. For some years past, however, its original reputation has been on the decline; the original vessels had become old and slow, and some of them had been lost, while the new vessels which had been added to the company's fleet, instead of being better than the old, were in most cases worse, so that the *prestige* with which the company started was no longer maintained.

The result of this state of things was, that various proposals for establishing a rival company were entertained; and it became obvious to me that, if a rival company were established, one of two consequences would ensue—either the new company would get the mails to carry, or if the old company succeeded in retaining them, it would only be after such a

* From Treatise on the Screw Propeller, by J. Bourne.

† From the London Artizan, August, 1852.

keen competition, and on such stringent conditions, that the service would hardly repay any contractor. Under these circumstances, I communicated with my father, who was then still living, and with some of the other directors of the company, pointing out the course which it appeared to me ought to be pursued under the circumstances related; and my recommendations were to the following effect.

It was quite clear that the very general dissatisfaction which had been expressed at the want of power and speed in the company's vessels was not unfounded. Here was a line, confessedly the most important of all our lines of postal communication, on which the vessels built ten or twelve years before were still the best, the more recent vessels being, for the most part, exceedingly slow and inefficient, when compared with other successful vessels of recent construction. It was quite indispensable, therefore, in order to meet the just expectations of the public, that vessels capable of maintaining a higher rate of speed should be introduced; and as the introduction of such vessels by some party or other was inevitable, it would not be advisable to postpone the improvement until the attempts of rival parties had been so far organized, that competition could no longer be averted by any expedient of amelioration. All this was very clear; but the question at once arose, what was to be done with the existing vessels? Attempts had been made to accelerate some of them by the application of feathering wheels, but with very inadequate results; and all attempts at petty improvements appeared to me not only futile, but injudicious, as such attempts involved a considerable expense, and practically left the vessels still unequal to the exigencies of their vocation. Now, seeing that it would be impossible to sell the existing vessels without immense sacrifice, and that it would be equally impossible to retain them, unless a radical change in their efficiency could be effected; and seeing, too, that the usual means of acceleration had been tried, at a heavy expense, but without any material benefit, it occurred to me that, upon the whole, the most judicious course would be to introduce into each vessel a separate engine, which would drive a screw, working in the stern of the vessel, in aid of the paddles; and by this arrangement it was obvious that any increase of power and speed might be given to the existing vessels that the exigencies of the case required. I recommended, therefore, that one of the smaller vessels of the company, the *Madrid*, for example, should have a screw fitted at the stern, to aid the operation of the engines; and I found that a pair of screw engines, of the same power as the existing paddle engines, of 140 horse power, could be supplied for about £800; the screw engines being light and cheap, as they would be without air pumps and condensers, and would be connected immediately with the screw shaft. If the result answered the expectations formed of it, a similar arrangement could, it was obvious, be introduced into the larger vessels without any very great expense, and those vessels would thus be enabled to maintain a rate of speed exceeding anything then existing in ocean steam navigation, and the dilemma in which the company stood of having to discard their present vessels, or lose the mail contract, would be dissolved.

This suggestion has met with the same reception and the same fate as that which I had previously made for the better ventilation of the vessels.

At first it was looked upon in the light of a great deliverance; but it has since been suffered to languish and die out, my father's advanced age, and subsequent illness and death, having prevented him from taking those active steps for its furtherance which otherwise he would have felt called on to pursue. The mechanical part of the question was referred to Mr. Penn for his opinion, whose views completely coincided with my own, the only difference being, that he stated them with greater clearness and force than I should have been able to do. Other leading engineers to whom the proposed arrangement has since been mentioned concur in the conclusions at which I had arrived. As every one of ordinary engineering attainments will be able to form a judgment for himself upon this subject, I shall here recount the nature of the intended arrangements, and the extent of the benefit which, according to my estimate, would have been obtained.

I have already mentioned, that if the power of any given vessel be doubled, her speed will be increased nearly in the proportion of the cube root of 1 to the cube root of 2. A vessel, therefore, which maintains a speed of 10 knots with any given power, will maintain a speed of about 12½ knots with twice the power; and I proposed that the power of all the Company's vessels running on important lines should be doubled wherever the usual speed did not exceed 10 knots an hour. Now this duplicature of the power I proposed to accomplish without touching the existing engines at all, and, as I have already mentioned, I proposed to apply a screw in the stern of the vessel, which was to be driven by separate direct acting engines of its own. The screw engines would not have had either air pumps or condensers; but the steam from the boilers was to enter the screw engines first, and after having given motion to them, would have passed into the paddle engines, where it would have been condensed in the usual manner. By this arrangement, the steam would have been used twice over, and twice the amount of engine power would have been exerted in the hour, without any increase in the consumption of coal. To enable these arrangements to be carried into effect, it would be necessary to work with a higher pressure of steam than has heretofore been employed in these vessels; and I proposed to use a pressure of about 25 lbs. on the square inch, which was about three times the pressure then employed. To enable this pressure to be used with perfect safety, I proposed that the boilers should be circular—such as Mr. Penn has since put into the *Hydra*, which may be worked up to 30 or 40 lbs. on the square inch, if required. It would, of course, be impossible to put any such pressure as I proposed to use upon the existing paddle engines, as it would have broken them down; but the steam was to act, in the first instance, upon the pistons of the screw engines, after having given motion to which, it would pass into the paddle engines, and be there condensed in the usual manner. There is, therefore, only the same quantity of steam to be generated under the new arrangement as under the old, and it would be generated, of course, with the same quantity of coal: but after having been employed in the cylinders of the screw engines, and been there expanded down to that point of elasticity with which the paddle engines at present work, it was to be conducted into the paddle engines, and to work them in the same way as if steam of that elasticity had come direct from

the boiler. The proposed arrangement, therefore, is analogous to that of a Woolf's engine; but as the engines employed to drive the screw would work at a high velocity, they would be smaller than the high pressure cylinders of a Woolf's engine, in the proportion of their increased speed.

It will be obvious, from the exposition I have given in the foregoing pages of the mode of action of the screw in the water, that a screw acting in aid of paddles would work far more efficiently than if it were employed alone to propel a vessel; for, as the vessel is at all times moving through the water from the action of the paddles, the screw will always have a column of water of a considerable length to act upon at each revolution, and the slip will be diminished in consequence. And as, by the operation of the paddles, the action of the screw is amended, so will the action of paddles be amended by the action of the screw. For, since the vessel will pass faster the water when an auxiliary screw is added, the paddles will gear into a greater length of water in a given time, which, as it will possess more inertia without any more pressure being employed to move it, will be operative, to a corresponding extent, in reducing the slip of the wheel. In fact, both propellers will act constantly under the same favorable circumstances as if the vessel were always sailing with a fair wind; for the screw is virtually a fair wind to the paddles, and the paddles are a fair wind for the screw.

It will be further obvious, that by adding to a paddle vessel screw engines of the same power as the paddle engines, the total power of the vessel will be somewhat more than doubled; for, when the speed is increased from 10 to 12½ knots, the speed of the paddle engines will be increased also, so that they will give out a fourth more power than before; and the increased speed of vessel due to this small increase of power will, in its turn, somewhat increase the speed and power of the screw engines. But this increase of the power I have not thought it necessary to reckon, seeing that it would only be obtained with an increased consumption of fuel, and that the speed of the vessel will not increase quite so rapidly as the cube root of the augmented power. Now, if the speed of the vessel be increased one-fourth, and the consumption of fuel, per hour, only remains the same, it is clear that the vessel will require one-fourth less fuel for the accomplishment of a given voyage. Instead, therefore, of the vessels employed upon the Indian line having to carry about 600 tons of coal, they would only require 450 tons for the performance of the same voyage under the proposed arrangement, and the weight thus saved would fully compensate for the extra weight of the screw engines and screw.

From these considerations it appears, beyond doubt, that, by the proposed mode of acceleration, about one-fourth more speed would have been obtained with a smaller consumption of fuel, and without any increased weight in the vessel. The only topic remaining for consideration is, whether boilers using such a pressure as 25 or 30 lbs. would be quite safe in steam vessels, seeing that the boilers of steam vessels sometimes get incrusted with salt, when, possibly, the furnaces may get red hot. Now, it is quite clear that any boiler which is suffered to get red hot, from whatever cause, will be productive of danger; but such an occurrence is a very rare one; and I consider that the risk of salting may be obviated by an expedient mentioned to me by Mr. Penn, as a suggestion of

Mr. Spiller's, and which appears to me to afford a perfect security against the danger. This expedient consists in the application of a feed pump, which is purposely made too large to supply the quantity of water requisite for the generation of the steam, and which is not provided with any means of shutting off the water, or allowing the surplus to escape. It will follow, consequently, that a good deal more water will be sent into the boiler than what can be raised into steam, and the surplus must be blown out by the engineer; or a self-acting float may be applied to the boiler, to permit its escape when the level of the water rises above a given point. With this simple provision it will be impossible that the flues of the boiler can ever become incrusted to an inconvenient extent, whether the boiler is leaky or not; and any objection based upon the supposition of such a possibility must of course disappear when the possibility itself no longer exists. The question, however, is not so much whether boilers with a pressure of 25 or 30 lbs. may be made as safe as boilers of a much lower pressure, but whether they may be made as safe as boilers with nearly the same internal pressure, but which are by no means adapted to sustain it. In modern sea-going steam vessels, 20 lbs. on the square inch is a frequent pressure; and in a few instances the pressure is as high as 25 lbs. These boilers, nevertheless, have flat sides, and depend for their strength upon stays, which after some time corrode, and may even be eaten through, leaving the boiler in a very unsafe state. The pressure, indeed, is always reduced in these vessels, as the boiler gets into a state of dilapidation; but such an adjustment rests the responsibility of the safety of the boiler upon the engineer, and is a practice likely to lead to accidents. Instead, therefore, of loading the boiler at the first to its maximum strength, and gradually reducing the pressure as it gets into disrepair, it appears to me to be by much the safest course to make the boiler of such a construction, at the outset, as to enable it, without the aid of stays, to withstand a very much higher pressure than is put upon it; and it will then continue to be safe even when old and worn. This, accordingly, is the course which I proposed to pursue, and it still appears to me to be the most eligible that could be adopted.

These comments have extended themselves to such a length, that the remarks I have to offer respecting the comparative advantages which vessels propelled both by the screw and by paddles would offer relatively with those presented by vessels propelled by either screw or paddles alone, must be despatched very summarily. It is only in the case of vessels intended to maintain a high rate of speed, upon voyages of considerable length, that I would propose to employ both the screw and paddles; but in those cases the combination has very obvious advantages, if the comparison be made with that measure of efficiency which screw and paddle vessels have heretofore respectively attained. Paddle vessels, when deeply, are unable to exert their power with good effect; whereas, under those circumstances, the screw acts in its best manner. On the other hand, a screw vessel set to encounter a head wind wastes much of the engine power in slip; and the performance would be improved, under such circumstances, if half the power were withdrawn to work paddles, since not only would the paddles act in such a case with great efficiency, but the advance they would give to the vessel would enable the screw to

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act with greater efficiency also, as it would be perpetually coming into a fresh body of water, whereby the slip would be reduced. A vessel, therefore, propelled by paddle engines of 500 horse power, and by screw engines of 500 horse power, would be more efficient, when deep, than the same vessel propelled by engines of 1000 horse power driving paddles; and more efficient, when set to encounter head winds, than the same vessel propelled by engines of 1000 horse power driving a screw. In fact, by the proposed combination, a higher average measure of efficiency would be attained, and in so far as the screw engines would be lighter and more compact than paddle engines of the same power, a further benefit to that extent would be obtained also. The paddles, moreover, would not require to be of such inconvenient dimensions as if the whole power had to be transmitted through them, and yet a very effective hold of the water would be obtained. Should either the paddles or the screw be deranged by any accident and be unable to work, the vessel would still be able to proceed by the remaining instrument of propulsion, at a diminished rate of speed. Upon the whole, therefore, I am of opinion that vessels constructed on this plan will be better than if propelled solely by paddles, and they will be better also than vessels propelled solely by the screw, if the mode of applying the screw be the same as that which has been heretofore in use; but they will not be better than vessels propelled solely by the screw, if the screw be applied in the manner I have recommended, so as to enable screw vessels to proceed in an efficient manner against a head wind. It is mainly, however, as a means of accelerating the speed of existing paddle vessels that the plan is to be recommended, and I do not know of any mode by which an effectual measure of acceleration can be ensured with so small a disturbance of the existing mechanism, and at so small an expense. In reflecting upon the various means of accelerating vessels, when I first entered upon the consideration of this subject, other modes, as may be supposed, suggested themselves of accomplishing the same object. One of these modes was the use of feathering wheels, and the reduction of the diameter of the wheels, so that a higher velocity of the engine would be obtained. But this expedient, it was obvious, would only fall into the category of petty ameliorations, since it would be impossible to reduce the diameter of the wheel very much in vessels of a varying immersion without introducing other evils; and it did not appear advisable, moreover, to increase the speed of the engines very much beyond that at which they then worked, as many of the arrangements were not suited to a high velocity. Another idea was to interpose gearing between the engine and paddles; but this expedient had much the same objections as the preceding; and if either of these plans could have been carried into effect, it would have been necessary to increase the area of the floats in the proportion of the increase of power, else the slip would have been augmented. In both of these plans, moreover, the consumption of fuel would have risen in the same proportion in which the power was increased; whereas, by the application of an auxiliary screw in the manner I contemplated, the increase of the power would not have occasioned any increase in the consumption of fuel per mile, but would have been less than before. In all cases, therefore, in which it is desirable to increase largely the speed of

a paddle vessel, that object will, in my judgment, be best attained by the introduction of an auxiliary screw worked by direct acting engines, which receive steam of a considerable pressure from boilers of appropriate construction, and transmit the steam in an expanded state to the paddle engines, to be there condensed in the usual manner.

Explosions in Coal Mines.—Report from the Select Committee of the House of Commons, appointed to inquire into the Causes of the frequency of Explosions in Coal Mines. (*Ordered, by the House of Commons, to be printed June 22d,* 1852.)*†

The Committee, considering the pressing emergency of the matter committed to their charge, how deeply the interests of humanity were involved, (the deaths from explosions having latterly increased to the fearful number of about 1000 per annum,) determined only to examine witnesses of the highest and most experienced character, in the hope that they might be able to derive sound information, on which to recommend additional means for the prevention of such wide-spread calamities during the present session. The Committee are therefore of opinion—

That any system of ventilation depending on complicate machinery is unadvisable, since under any disarrangement or fracture of its parts, the ventilation is stopped or becomes less efficient.

That the two systems which alone can be considered as rival powers, are the furnace and the steam-jet.

The *furnace* system, under favorable circumstances—*i. e.*, of area of the shafts being large and deep, the air-courses sufficient, the goaves (or old workings) well insulated, and the mine not very fiery, appears to be capable, with strict attention, of producing a current of air that will afford reasonable security from explosion; but when the workings are fiery and numerous, as well as remote, and the intensity of the furnace or furnaces requires to be raised in order to increase, on any particular emergency, the amount of ventilation, then the furnace not only refuses to answer the spur and to increase ventilation, but from a natural law, (discovered by Mr. Gurney, and scientifically and practically confirmed before the Committee,) there arises a dangerous stoppage to ventilation going on throughout the mine.

The quantity of heat generated by the furnace is directly as the quantity of fuel that can be consumed in a given time. The amount of rarefaction or power of the upcast will always be directly as the temperature of the column of air passing up in a given time, which temperature will vary in proportion to the quantity. The amount of heat of the furnace is a constant quantity, which will be spread over a more or less quantity of air. The power of the upcast rising in *an arithmetical ratio;* the friction or drag of a current of air through the workings of a coal mine, offering a

* We have thought it necessary at present to give only the leading features of this Report, but shall probably return to the subject when the Minutes of Evidence given before the Committee are made public.—Ed.

† From the London Civil Engineer and Architect's Journal, July, 1852.

resistance, equal to the *squares* of its velocity. Now it is manifest there will soon be a point where the resistance overtakes the power. The power being as an arithmetical ratio, while the resistance increases in a geometrical ratio, the "furnace limit" will be the point where these two powers balance each other. This limit commences in practice much earlier than would appear on calculation from these data, because there is another element to be taken into calculation that seems never to have been noticed. This element is the resistance offered to the air going through a mine by the *vena contracta*. It amounts to a serious quantity in the workings of an ordinary coal mine. This amount of extra resistance, added to the friction arising from the rate of current, adds considerably to the rate of increase of the drag. This important fact has never hitherto been noticed; nor was it referred to by any of the witnesses in the Committee of 1835, or that of the Lords in 1849.

The resistance or drag of a current of air passing through the working of a coal mine is, as stated above, as the squares of its velocity. When this resistance is so great that the proper quantity of air cannot come through the galleries of a mine to fill the exhaustion produced at the bottom of the upcast-shaft, it will come down through the shaft itself, as the easiest channel. It will come down on one side, leaving room on the other for the hot air to ascend, the stationary particles of air between the two moving currents forming an imaginary aerial plate. The plate has been called the "natural brattice."

The amount of resistance of currents of air coming through the workings, increase as the *squares* of their velocity; the power of exhaustion by the upcast-shaft is *directly* as its temperature. If the quantity of air passing through a mine be reduced by increased friction or obstruction, that smaller quantity of air will be raised to a higher temperature by the furnace in the up-shaft, and the exhaustion arising from its increased temperature will produce a greater amount of *force*. The water gauge is a measure of this force of exhaustion or power of the furnace. Under the above circumstances, the water gauge will rise and indicate a *greater power*, while the *amount* of ventilation is reduced. This is a seeming fallacy: it is not a fallacy; therefore, is called the "furnace paradox."

To the powers of the *steam jet*, on the other hand, there appears to be no practical limit; for although it acts, when placed (where recommended) at the bottom of the upcast, as a rarefier to the extent of the steam used, and fire under the boiler, its principal or direct efficiency depends upon its power of propulsion. The heated air not only rises from rarefaction, but any amount of cold air can be bodily pushed up the upcast, the amount merely depending on the number and size of jets employed, and the pressure of steam. The Committee are unanimously of opinion that the steam jet is the most powerful, and at the same time, least expensive method for the ventilation of mines.

Previous to 1848, when Mr. Forster introduced the steam jet into the Seaton Delaval mine, the fire-damp was constantly seen playing around the face and edges of the goaves and other parts of the workings; since that period the mine is swept so clean that it is never observed, and all danger of explosion seems removed in a very fiery mine. The increase of ventilation is from 53,000 cubic feet per minute under the furnace

system to 84,000 under the steam jet; and to double that quantity, which Mr. Forster considers sufficient, would, he says, only require the application of some extra jets. Mr. Forster states the original outlay for the steam jet to be less than for the furnace by £39 15*s.* 6*d.*; and the annual cost to be less by £50 12*s.* 1*d.*; while the power of ventilation is increased to nearly double.

Notwithstanding the increase of ventilation which Mr. N. Wood states he has obtained in one of his collieries, where the areas of the shafts are very large, and by the aid of three furnaces, it appeared in evidence that the explosion at the Killingworth Colliery last autumn, under Mr. N. Wood's management, took place under the furnace system of ventilation.

Although a few of the witnesses (two of the most intelligent of the government inspectors among the number,) seemed to have misunderstood the mode in which the steam jet operated as a ventilator, and professed themselves so far unacquainted with it as to be unable to form an accurate judgment on its merits, all the witnesses, with scarce an exception, coincided in the opinion that in a fiery mine, even where the furnace system was thought sufficient under ordinary circumstances, it would be a prudent and almost necessary precaution to have a steam jet apparatus at the top of the downcast connected with the boiler of the engine which worked the mine, in case a sudden and great increase of power was required, under pressing emergency.

It was stated in evidence that 70 per cent. of the deaths from explosions were occasioned not by the explosion of fire-damp, but by the "after-damp" which succeeds it. If the latter be inhaled in its pure state by the miner, it causes immediate death. But since, from the miners being subsequently discovered in various stages of prostation, it is apparently inhaled in various degrees of dilution, it seems clear that a power like the steam jet placed at the top of the downcast, out of reach (which the furnace at the bottom of the upcast occasionally is not) of the effects of the explosion, and capable of sweeping the galleries of the mine with an almost irresistible force immediately after the explosion, might be the means of saving a large proportion of the lives now lost for want of such a power. The furnace under such pressing emergency is inapplicable, and incapable of being used for the purpose.

The Committee, however, are unanimously of opinion, that the primary object should be to prevent the explosions themselves; and that if human means (as far as known) can avail to prevent them, it is by the steam jet system as applied by Mr. Forster; although even in such case it might be prudent in a mine especially fiery to add an inexpensive steam jet apparatus at the top of the downcast, as a means in reserve in case of explosion from neglect or otherwise.

The proper condition of a mine, as regards its ventilation, the Committee consider is when the current of air through all the air courses, more particularly in the extreme workings, is from four to six feet per second in rate through an ordinary sized air-way, of (say) 50 feet sectional area; this, in the extreme workings, would command a rate of current to a much greater extent (and which would be necessary) through the less remote workings of the mine. Without a current of air at the rate of at

least four feet per second, equal to about three miles per hour, in *every part* of a mine at all fiery, the miner cannot be considered safe from explosion. Such current would be the truest indication of the actual amount of fresh air circulating through the general workings of the mine. It seems immaterial by what mode this rate of current is produced, so that it be certainly produced, and a means be furnished to the inspector at each visit to ascertain that such rate of current has constantly existed during his absence.

The attention of the Committee has been directed to scientific and practical means of decomposing or neutralizing the explosive gases as they exude from the coal and goaves; but it does not appear that science has discovered any practical means for producing this desirable effect. Mr. Blakemore, M. P., has offered, through the Royal College of Chemistry, a premium of £1000, for the discovery of some simple practical means for the attainment of this important object.

The Committee would now refer to some more incidental means of security against explosion; first, stating their concurrence in the opinion expressed, directly or indirectly, by the Committees of 1835 and 1849, and also with that so strongly expressed by the South Shields Committee, that where a proper degree of ventilation does not exist in a mine, the Davy-lamp, or any modification of it, must be considered rather as a lure to danger than as a perfect security. Practically secure in a still atmosphere, it may be considered; and in the hands of a cautious over-man, an admirable instrument for exploring, or as an indicator of danger; but in a current, as admitted by its illustrious inventor himself, it is not a security; and in the hands of an ordinary workman, under circumstances of excitement, when danger is threatened, it is not improbably, far oftener than imagined, the very cause of the explosion which it is intended to prevent. The experiments of Dr. Bachhoffner, at the Polytechnic Institution, before the Committee, were very interesting on this point. Nevertheless, in a mine that is at all fiery, it will be a prudent precaution to work with a lamp, until it can be proved that by means of ventilation a mine can be so far cleared of all explosive gases as to prevent any accumulation of them in the workings, goaves, or elsewhere. Some of the witnesses point to such a possibility; and if it were for the sake of the health of the miners alone, a current of fresh air passing through the mine which could produce this effect, would render such a power one of the most valuable contributions of the age. One of the principal objections to the Davy-lamp, on the part of the workmen, has been the insufficient light which it affords. A lamp of greater reflecting power, which would at the same time admit of a double gauze protection, has been suggested. It is made of polished wire gauze, instead of black iron wire. The latter has an absorbing surface, the former has a reflecting one; the latter intercepts and obstructs more than half the light given out by the flame; the reflecting lamp reflects the light which falls on the meshes of the wire gauze, and sends the rays out on the opposite side, in a profitable direction.

In the furnace system of ventilation, the power depends on the difference of the temperature of the air going down the downcast shaft and that coming up the upcast; and when the temperature of the outer air is high, the power of the furnace is reduced. When the thermometer, there-

fore, exhibits a high rate of temperature, the ventilation is lessened. This may account for accidents being generally more frequent in spring and summer.

Under the ordinary pressure of the atmosphere, its weight operates in a fiery mine to keep back the escape of gas from the recesses of the mine. When the pressure is less, the explosive gases have greater power of escape. Whenever, therefore, there is a fall in the barometer, showing a diminished pressure of the atmosphere, danger is indicated, and an increased amount of ventilation required. In every mine, therefore, it should be imperative for a barometer to be kept. It should be placed near the ventilating power, properly connected with the external air, through the downcast, so as to take the pressure of the atmosphere. A "Differential Barometer" is much more sensitive than a common one, and should be used; and since it costs only a few shillings, there would be no excuse for not having one. The differential barometer, so called, is more delicate in its movement than an ordinary barometer; it may be made almost to any ratio of delicacy. It would show a change taking place in the weight of the atmosphere long before it could be seen in the ordinary barometer, and therefore be highly valuable in a coal pit. On the fall of the barometer, fire-damp issues out of the goaves and recesses of the coal in larger quantities than usual, so that ventilation requires to be increased under such circumstances, and the fall in the barometer points it out before it can be otherwise seen. The barometer is said to be more useful in a coal pit than in a ship. It indicates impending storms, or change of weather, and the more delicate it is the better. The index of the differential barometer can be made to range from 50 to 100 times through a greater space than the ordinary mercurial level; and therefore slight changes in the weight of the atmosphere can be read off by this instrument, which are invisible or inappreciable in the common barometer.

A water gauge should be placed at the bottom of the upcast, to indicate the power of the drag of the mine, where the furnace is used, so as to indicate the proximation of the furnace limit. The water gauge is a tube of glass bent in the form of the letter U, one end of which communicates with the upcast and the other with the downcast shafts by a pipe; it contains a little water at the bottom of the bend, and is an indicator of the *amount of power;* its extent of break of level in the two legs is a measure of the actual *force* which is necessary to overcome the "drag of a mine." When this force is known, its rise or fall indicates whether proper ventilation is going on in the extreme workings or not; thus if the air comes through the workings by a shorter passage than it ought to do, the water gauge will immediately fall. In a late explosion, occasioned by leaving a door open between the downcast and upcast shafts, the water gauge would have pointed it out. If the water gauge rises above its working point, it shows obstruction existing somewhere in the workings. If it stands at its working point, it shows that ventilation is going right. It is a most useful instrument; it is a measure of the actual power required for ventilation, and in the possession of a practical man, will tell him where and how ventilation is going on by simple

inspection. In connexion with the anemometer, this gauge is most valuable.

But an instrument of even greater importance than the above, especially in reference to the periodical visits of inspectors, is a self-registering anemometer, by which the inspector would know at each visit the rate at which the current of air had been passing through the mine in his absence. The best instrument of this kind at present known, perhaps, is that of Mr. Biram. Three, at least, of these should be kept in every mine; one at the intake (bottom of downcast shaft), one at the return (bottom of upcast), and, especially, one or more in the extreme workings. By the anemometer the *actual quantity* of air passing may be known; and at the same time, by the water gauge, the *absolute force or power* required to move or pass that quantity may be known; so that by these two instruments the amount, power, and probable state of ventilation may be ascertained.

The goaves (old workings) in extensive mines are a principal source of danger. It has been suggested, if the water would permit, that the goaves might be as it were drained of the explosive gas by a bore-hole from the surface, acted on by a steam jet; that gas, being lighter than common air, would thus be drawn through the bore to the outer air.

For a similar purpose, a system of gas drifts along the *rise* of the coal deposit, intersecting its cleanages, banks, and interstices, and taken to the upcast shaft, might be, and in some cases has proved to be, a practical and scientific means for removing the light carburetted hydrogen gas from the coal, without permitting it to descend into the workings.

It was suggested by Mr. Gurney, also, that refuge stalls might be established at small expense, in places familiar to the miners, throughout the workings, to which, upon an explosion, they could at once fly from the fatal effects of the after-damp. At the ingoing end of the ordinary stalls, bays, or cul-de-sac recesses of the workings in a coal pit, boarding must be placed, so as to insulate it from the main air-courses, sufficiently strong to withstand the force of a moderate explosion at the spot; or of a violent one at a distance. In this stopping two openings are cut, one at the highest level, and the other as low as possible, so as to effect self-acting ventilation; by which means the bay will always be filled with good air. They also relieve the stopping from the force of explosion. On the inside two valves are suspended, so as to be always ready, in case of need, to close the openings from within. The upper opening is small, about four to six inches diameter; the under opening is sufficiently large for a man to pass through. In case of explosion, instead of the men running, as they now do, into the main air-courses, and consequently into the after-damp, they may go into these refuge stalls, close the openings, and remain there till the after-damp is removed. Taking into consideration the quantity of air required to support life for a given time, and the ordinary size of the stalls, it is clear that men may remain in them in safety for 24 hours, or longer, when properly constructed. During this period the after-damp ought to be withdrawn from the workings. These stalls are inexpensive, require no attendance, and may be made and left, or removed, at short distances, as the ordinary workings of a coal mine proceed. They should be within a hundred yards of each other, so that

one may be always at hand. A few pitmen only would be there, and have occasion to go into the same refuge. The well known laws of pneumatic disturbances show that, properly constructed, it would practically be sufficient to insulate and preserve the atmosphere of the refuge from danger of interchange with the after-damp for a long time together. In the midst, or *close to*, a violent explosion, the stoppings might be blown down; but not at a short distance. A violent explosion would produce death, by its force, in its immediate neighborhood; but in such case the refuge stalls would under any circumstance be useless. They are intended only as a protection against loss of life from *after-damp*. It has been proposed to place large safety flaps or valves in the stoppings, to guard against the force of explosion, but this seems unnecessary.

It has been stated in evidence, that boys are employed in mines to perform duties, the neglect of which in a single instance might be productive of great loss of life. They are employed, in particular, to attend to the opening and shutting of the doors or traps necessary to regulate the courses of air in every system of ventilation. It has further been stated, that even in the best disciplined pits, where the men are rarely, if ever, guilty of serious acts of neglect or carelessness, it has yet been found impossible to guard against similar negligence on the part of the boys; and accordingly it appears that in various instances fatal accidents have been traced to such negligence in the performance of the duties allotted to them. The Committee, therefore, are of opinion, that no responsible duties, the neglect of which would involve serious risk of life, ought in any mine to be entrusted to boys, or to any other class of inexperienced persons, but solely to persons in whose judgment and discretion full reliance can be placed.

Education is a point insisted on as a precautionary means both among the working colliers and their managers, as also that the qualification of inspectors should be rigidly tested previous to their appointment. In these views the Committee entirely concur. They not only trust to see education more rapidly spreading than heretofore among the working colliers, but schools of mines established, without certificates from which no overman, under-looker, or manager, shall be legally appointed to his office.

The qualification of inspectors for their office is a point of the first importance, and should be efficiently tested before a competent board, analogously with the tests exacted in various professions where the interests of life and health are involved. They should be acquainted generally with natural philosophy (especially pneumatics), chemistry, mechanics, also a competent knowledge of geology and mineralogy; and should also have had practical experience of colliery working.

Almost every witness, however, bore testimony to the total inadequacy of the present system of inspection. The numbers were too small, its powers too limited. Each of the inspectors summoned before the Committee had something like 400 mines in his district, the whole of which he would be unable to go through in less than four years. Many mines they had never visited. The Committee cannot therefore hesitate to recommend that the number of inspectors should be increased. They at present amount to six. That number probably should, at least, be

doubled, and two sub-inspectors to each chief inspector be added. In a letter of Sir H. de la Beche to the Committee, it is indicated, and it appeared also in evidence, that the present salary of an inspector was too small, at least to induce a person really fitted for the office of inspector to remain in his situation.

The Committee, for their own part, feel disposed rather to trust to the appointment of an efficient and vigilant Board; to an increased number of well-qualified inspectors and sub-inspectors, who should practically have the power of enforcing such a rate of current of air through the various parts of the mine as, in their judgment, the safety of the miners required, together with the adoption in each mine of such scientific instruments as both preserved a register of the ventilation, and gave warning of danger; that these powers should extend to the inflicting penalties for the non-possession of such instruments, and non-attention to the precautions recommended, and to stoppage of the mine until the right measures were taken. Such measures, together with the better education of the miners, and the establishment of schools of mines, and the circulation among the colliers of such rules and regulations as are adopted in the pits of Mr. Forster and Mr. Darlington, the Committee consider would go far to diminish, and ultimately almost entirely to prevent, the dreadful explosions to which their attention has been called.

On the Manufacture of Malleable Iron and Railway Axles. By George Benjamin Thorneycroft, Assoc. Inst. C. E.*

Malleable iron may be divided into two distinct classes—"Red-short" and "Cold-short," the former being generally produced from the rich ores, and the latter from the poorer, or leaner ores.

The pig-iron made from the rich ores (under the cold blast process only) is not so fluid as that from the lean ores; when, however, it has been converted into malleable iron, it is tough and fibrous when cold, but is troublesome and difficult to be worked by the smiths at less than a white heat; this want of ductility has caused it to be denominated "Red-short."

The pig-iron produced from the lean ores possesses, on the contrary, more fluidity, and it is thence well adapted for small castings; but when it is manufactured into malleable iron, although in the hands of the smith it is ductile and is easily worked, even at a dark red heat, it becomes, when cold, weak and unfitted to support sudden shocks, or continued strains, and is hence called "Cold-short."

It is obvious, that to obtain qualities of iron suitable for the various purposes to which it is now applied, a judicious mixture of these two kinds must be made; but even this will not suffice, unless the pig-iron, forming the basis, be of a proper quality. It may be received as an axiom, that good malleable iron can only be made from good dark, and bright gray pig-iron, smelted from iron ore alone, or with a very small admixture of any extraneous substance. Iron made from white pig-iron alone is never ductile, although it may be cold-short, whilst it differs materially from

* From the London Civil Engineer and Architect's Journal, August, 1852.

the red-short iron, made from rich ores; in fact, it possesses no good quality either hot or cold, and may be termed "Rotten-short."

The quality of the fuel used in the smelting furnace and in the subsequent processes is very important, for the produce of the best ores may be rendered utterly worthless by the use of inferior fuel; on the other hand, iron made from rich ores, and having great strength when cold, but which cracks in working at a red heat, if smelted with very pure coal, or charcoal, retains all its strength; whilst it becomes much more ductile than if an inferior quality of fuel had been used. Hence, when a strong ductile iron is required, the best fuel must be employed in its manufacture.

The introduction of hot blast for smelting iron rendered necessary a careful investigation into the comparative use of hot and of cold blast pig-iron in the manufacture of bars; the result of this would appear to indicate that if the same quality of materials be used in both cases, equally good bar iron will be produced; but it is more difficult to convert the hot blast pig-iron into "number one" bars, and the waste is greater, than when cold blast iron is used.

It is certain, that whilst good gray pig-iron can only be produced, by cold blast from the best materials, iron of apparently excellent quality can be produced, by hot blast, from the most sulphurous ore and fuel; indeed, to this alone must be attributed the bad reputation of hot blast iron for certain purposes. Castings for the forge and mill, such as rolls, housings, hammers, anvils, &c., which require great strength, as being subjected to considerable strain, or to sudden concussion, should not be made of hot blast iron. Wherever strength and durability are required, a mixture of qualities of iron is essential, in order to produce metal having a bright gray fracture, slightly mottled, which is the best quality. Any nearer approach to gray renders the casting weaker, as the more highly carbonized cast iron becomes (whether hot blast or cold blast), the softer and weaker it becomes, and it can only have strength imparted to it by a due admixture in re-melting. The mixture is generally the result of the experience of the workmen, as no definite system has been laid down, nor have a sufficient number of experiments been made to establish any certainty on the subject.

The same kind of distinction takes place in the texture as in the character of malleable iron—that is, the red-short quality is most inclined to possess a fibrous texture, and the cold-short to present a crystalline or granular fracture, though these characteristics can be materially modified or altogether changed, by judicious mixture and by re-working, and even fibrous iron can be made very ductile; this quality, however, will become granular, when a number of bars, all of the best quality, are bound together, and subjected, in the process of faggotting, to a sufficient degree of heat to weld them into a homogeneous mass; but if that mass be worked down again with a moderate heat into bars of the same size as those from which it was originally made, the fibrous texture will have been recovered. Such iron, whilst in the granular state, will bear impact better than if it had been made of bars whose texture was originally granular.

Malleable iron becomes granular from two causes: first, in consequence of being made from naturally cold-short pig-iron; and secondly, from a

peculiar manipulation during the process of "puddling." If the iron be made up into balls as soon as the granulated particles will stick together, or as the workmen term it "put together young, before it has got into nature," the texture will be fine, and close grained, and the fracture will present a bright granular appearance; such iron will not, however, bear sudden impact, nor will it become fibrous in texture by working until it is reduced into very small bars, or into plate-iron. All granular iron is much harder when cold, and will endure longer than fibrous iron, although it is not so well adapted for general purposes.

It is easy to give a fibrous fracture to iron, by welding the "pile" or "faggot" at a low heat, so that the interior does not become thoroughly solid; but if a pile be subjected to a sufficient degree of heat to make it perfectly sound, and the iron presents a fibrous fracture throughout, when reduced to 1½ inch square or round bars, the quality must be very good.

It has often been asserted that the peculiar quality of some of the Yorkshire iron ores caused the fine granular texture by which the malleable iron of that country is distinguished; the author has, however, uniformly dissented from this opinion, and in order to test the fact, some pig-iron was converted into bars in Yorkshire, and a portion of the same metal was sent to the Shrubbery Ironworks, Wolverhampton, where it was worked up into bars of the same size; the result of this experiment completely verified the author's opinion, as bars of the finest granular fracture and of the strongest fibrous texture, were produced from the same quality of Yorkshire pig-iron.

Identical results were obtained from Staffordshire pig-iron when subjected to different kinds of manipulation.

Swedish iron often presents, in the same bar, both a fibrous and granular appearance. This arises from the method of manufacture, which is very simple: One end of a long pig of iron is placed in a charcoal refinery, and as much metal is melted off as will make a bloom; but the workman commences working it as soon as it begins to melt, and continues to do so until the quantity required for the bloom is melted off into the fire; and when the mass will adhere together, the bloom is brought out and hammered into a bar. It must be evident that by such a process the first portion will have been subjected to a much greater amount of manipulation than the latter, and thus two qualities of iron, or degrees of malleability, are produced in the same bar.

Independently of the alterations of texture which arise from peculiarities in the process of manufacturing iron, great changes are induced by certain actions upon it when cold. Compression, or impact upon the end of a bar of iron, will alter its texture from a fibrous to a granular character. This is well exemplified by two tools used by forgemen. The first is the "gag," which is a short bar of iron, of about 2 inches diameter, employed for holding up the end of the large helve during the intervals of working; it is subjected to impact endways whenever the lower end is placed on the anvil, and the other receives a vertical blow from the helve falling about an inch upon it. However fibrous may be the quality of iron used for making the "gag," it soon becomes brittle, and literally falls to pieces as if it were made of cast iron.

The second instance is that of the tool employed in puddling, one end

of which is constantly subject to blows from a small hammer, in order to detach the metal which adheres to the other extremity; after being some time in use, it frequently breaks at a slight blow, exhibiting a perfectly granular fracture.

If a bar of fibrous iron be bent down at a short angle, the fibres of one side are compressed, and those of the other side elongated; and after being bent back again, the fracture on the compressed side will exhibit a granular appearance, having evidently lost the fibre and been broken off short.

A bar of iron reduced in the centre and used as the connecting rod of a steam engine, by being subjected to constant vibration, or bending, will soon break at the middle, and the fracture will be perfectly granular, although it may have been originally made of the best quality of iron. The connecting rod for working the large shears in rolling mills, and the rods of deep pumps, when they are so small as to bend or vibrate at each stroke, are further examples of this action.

Iron shafting in mills working horizontally being generally too strong to bend, or to vibrate, apparently retains its fibrous quality, even when twisted asunder by a sudden action; but if it be so deficient in strength as to bend and vibrate whilst at work, it soon loses its fibrous nature and is destroyed.

Railway axles should be made parallel from journal to journal, and of sufficient strength to prevent any vibration in rotating. If this general rule were adopted, there would not be any change in texture, and consequently, a less number of fractures would occur. If it be considered necessary to reduce the substance of the middle of an axle, it would be safer to use good granular iron at first, as it is naturally much stiffer and less liable to bend and vibrate than fibrous iron, and would probably not change its form so soon, or receive injury whilst working under ordinary circumstances. It is, however, the author's opinion that axles should be perfectly rigid, so as not to bend or vibrate, even if that should have to be accomplished by making them somewhat larger in the centre, like the connecting rod of an engine.

Many other causes of change could be adduced, but enough has been stated to prove that the compression of iron, when cold, is certain to change fibrous into granular iron, and that vibration or bending, even to a slight extent, if continued for any length of time, has the effect of compressing all the particles consecutively.

A series of experiments was carefully made for the purpose of ascertaining, practically, the best form for railway axles, so as to obtain the greatest strength with a given weight of material. From these experiments it would appear that the forms generally adopted are very erroneous, especially in reducing the substance of the middle of the axles, and in turning rectangular shoulders near to the journals; and they proved, that by simply moving the face of the wheel back from the neck of the journal, the strength to resist impact was increased in the ratio of 100 to 30; that the relative strengths to resist impact where there is no shoulder, and where there is one, is in the ratio of 155 to 55; that the strength of a parallel axle compared with one which has been reduced in the middle, is in the proportion of 5 inches to 1½ inch. Again, it is well known that

the strength of round bars to resist transverse strain is as the cubes of their diameters, which would give the parallel axle an advantage over the reduced axle in the proportion of 83·74 to 58·18; and as the same law obtains in reference to torsion, if the velocity is the same, the strength to resist torsion will be in a like proportion.

Mr. Thorneycroft said, that though many discussions had taken place, at different times, on the subject of the crystallization or granulation of axle bars, no decision had yet been arrived at on the subject. He was prepared to concur with Mr. Stephenson in the opinion that if the iron was fibrous when worked into an axle, no subsequent jarring motion would alter its character. The granulation of iron might arise from various causes, but nothing so surely affected it as when a bar of iron was gradually bent, so that the fibres on the inner side would be compressed, whilst those on the outer side were extended; and as this process was continued, so the granulation progressed. He did not think that nicking the iron would materially influence the appearance of its fracture, nor would a blow, which merely caused a jar, destroy the fibrous character of the iron. This was well exemplified by two pieces of iron exhibited, which had been used as liners for a tilt hammer. That portion of each which had been compressed by blows, was granular in its fracture, whilst that which had been subjected to constant vibration remained very fibrous.

With regard to the forms of railway axles, it appeared to him, from the experiments, that the nave of the wheel should not be placed close to, but at some little distance (say ¾ inch) from the neck of the journal; also, that the shoulder behind the wheel should be entirely done away with; and instead of reducing the diameter of the axle in the middle, it would be advisable rather to increase its bulk at that point, like the connecting rod of an engine. He had never heard of a single case in which the texture of a fractured parallel axle had been changed from a fibrous to a granular character, although a certain amount of granulation had been repeatedly observed with axles which had been reduced in the middle, and had then been broken in course of regular working. It appeared in all such cases as if there had been a progressive and alternate action of compression and extension of the outer fibres, from the bending of the axle whilst it was rotating; and that thus the granular fracture had been produced.

Discussion.—Mr. Gibson said he did not consider it a fair test of the strength and utility of an axle to subject it to hammering, but that it would be preferable to deduce results only from practice. He had found that those axles which were parallel throughout did not bend in the centre, but at a distance of from 7 inches to 24 inches from the nave of the wheel; whereas, axles which were reduced in diameter in the middle, almost invariably bent in the centre. He thought the shoulder behind the wheel was advantageous when of a curved form, but not when it was square to the body of the axle. The shoulder merely served as a gauge for keying the wheels accurately on to the axle.

Mr. Beattie thought the quality of the iron used in the manufacture of railway axles was so important, that he had always advocated the use of the very best material; and to that precaution might in a great measure be attributed the comparative freedom from broken axles on the South Western Railway. With regard to the form of axles, he preferred those

without shoulders, and which were uniform in section between the wheels, because any vibration produced by sudden or violent blows, from the flanch of the wheels coming in contact with the rails, or passing through points, or crossings, would then be more equally distributed: whereas, if the axle was diminished in the centre, the vibration and strain would terminate there, so that the texture and cohesive quality of the iron would, in time, be completely destroyed. It was certainly very disadvantageous to place the nave of the wheel close to the neck of the journal, and shoulders were injurious both to the strength and durability of the axle, and in fact were, in many instances, the cause of their breaking; if, however, it was thought desirable to have shoulders, as gauges for keying the wheels up, they should certainly never exceed $\frac{1}{16}$-inch in projection.

Mr. Joseph Freeman said, as a proof of the importance of the best material and of good workmanship being united in the manufacture of railway axles, he might mention that there was not an instance of an axle made by the Low Moor Iron Company having ever been broken in work; this must be attributed to these combined causes. Much had been argued as to the particular form of the axle, and so far the Low Moor Iron Company agreed with Mr. Thorneycroft that the parallel axle was the preferable form; but he must contend that good material and sound workmanship were the main points.

Mr. Thorneycroft said that the whole series of experiments he had tried, strongly confirmed his previous opinions. He had lately examined fifteen engines in iron works in Staffordshire, including ten engines in his own works, and had found in all of them that the crank pin was placed in a line with the neck of the journal, thereby receiving the strain in the weakest place, and causing constant accidents; now, if the crank pin had been made $\frac{3}{4}$-inch, or even 1 inch longer beyond the face of the crank, leaving a space between it and the spear rod, the liability of accident would have been much reduced, by the strain being thrown on a part of the pin less liable to commence fracture. If a shoulder was left on an axle, it should be curved, for if it was left square, it would induce fracture at that part. It would appear that there was a constant progressive tendency to fracture wherever opportunity was afforded for commencing. Now, a parallel axle did not afford any spot for the commencement of fracture; on the contrary, the fibres extended unbroken throughout the length of the bar; and, unless from the undue weakness of the axle, a constantly recurring bending action occurred, by which the whole external fibres were compressed *seriâtim* as the axle rotated, there could be no tendency to break it; it was therefore important not to weaken an axle by diminishing the centre of it. In conclusion, though an axle reduced in diameter in the centre, might never have been broken, yet it was much more liable to be bent than a parallel axle, and as bending could not take place without compression, which he had shown completely destroyed the fibres of the iron and subjected the parts to sudden fracture, care should be taken to avoid bending in the least degree.—*Proc. Inst. Civ. Eng.*, *Aug.* 1852.

*On the Colors of a Jet of Steam.**

190. Professor Forbes some years ago observed, that a jet of steam absorbed the more refrangible portion of white light.† It happened during some experiments, that a blue jet of steam caught my attention, and further experiments soon assured me that it was easy to obtain a jet of almost any color.

191. A blowpipe jet was screwed on a T-piece, and the *opposite* opening of the T-piece was supplied with a stopcock, while the third opening of the T-piece communicated, by means of a tube, with the cock of the boiler. The blowpipe jet had an orifice about $\frac{3}{100}$ths of an inch diameter, and its axis was elevated about 28° above the horizon. The stopcock on the T-piece was furnished with a little contrivance, for preventing the steam that it discharged from interfering with the appearance of the steam discharged by the blowpipe jet; the use of this stopcock was to blow off the water which condensed in the steam passages. A pressure was maintained in the boiler of about 40 lbs. on the inch.

192. On fully opening the cock of the boiler, a jet of steam was obtained which appeared blue in nearly every position in which it could be viewed. Looking end on from below, the steam-jet caused that part of the heavens obscured by it to appear feebly orange-colored—the day was bright, but the sky at this quarter was overcast. On looking through the jet of steam from below upwards, but in a direction inclined about 11° to the axis of the jet—in which position a portion only of the steam-cloud could be viewed by the direct light of the clouds, the remaining portion being sheltered by the side of the window—one part of the jet appeared orange-red, namely, that part which transmitted the direct light of the clouds, while the other portion was blue. The blueness of the jet increased with the above mentioned angle until the angle was perhaps 30°, after which the blueness somewhat diminished, but was far from being extinguished at 90°.

193. By partly closing the cock of the boiler, and so discharging steam from the jet of, perhaps, not a higher presure than 10 lbs. on the inch, I could obtain a jet of steam; which, looking end on from below, was blue. It was rather difficult to obtain this blue jet, and when obtained, it kept alternating with violet. On now viewing this blue jet under an angle, as before (192) of about 20°, it appeared reddish-orange in color; this color was not visible at almost any angle, like the reflected blue (192).

194. Looking end on, and adjusting the pressure, I have occasionally seen for a moment at a time a bright green jet; also, and commonly, a blue purple. In the reflected tints I am not sure that I have seen anything more than orange-red, violet, and blue. The transmitted color appeared in my experiments more intense than the reflected tints. This, perhaps, has its explanation in the fact, that when looking end on, the eye receives light which has shone through a columnar arrangement, whose length is much greater than its diameter,—while the reflected lights could only be seen by looking on the convex surface of the columnar stream of particles.

195. Prof. Forbes, after discovering the red color of a jet of steam by

* From the London, Edinburgh, and Dublin Philos. Mag., Aug., 1852.

† Philosophical Magazine, S. 3, vol. xiv. p. 121.

transmitted light, connected the red color of the clouds with this fact; and the truth of this connexion is beyond dispute. So far, however, as I have been able to go, the colors of the steam-jet are manifestly only instances of ordinary interference, greatly resembling that produced by thin transparent plates; the transmitted ray being always complimentary to the reflected. Thus in (192) the transmitted light is red, as in Prof. Forbes's experiments, but the reflected light is blue. It is therefore to be inferred, that all the colors of the clouds originate in interference, caused by minute drops of water, the size of which determines their color; while the blue jet (192) is, I think, strictly analogous to the blue sky.

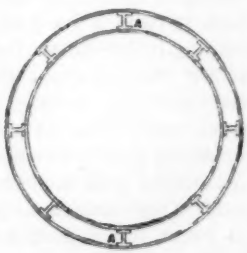
7 *Prospect Place, Ball's Pond Road, June* 28, 1852.

Note on the Construction of Sailing Vessels. By J. P. Joule, Esq., F.R.S.*

Since the now far by-gone times of Peter Pett, the great improver of naval architecture, the general form of ships' rigging has remained unchanged, or, at least, without any material alteration. In our finest vessels we have still the lower, top, and topgallant masts, supported by their respective shrouds and stays. The sails belonging to these masts have still pretty much the same contour; and although attached to the yard throughout the entire length of the head, they are only secured by the corners of the foot, or the clews, to prevent chafing with the stays.

This general form, sanctioned by the experience of centuries, is probably the best which could be employed with wood as the material for the mast; for the capabilities of wood, in resisting a crushing force, are so trifling, that it would be impossible to work a mast of it without lateral support from ropes. With iron, the case is different. The experiments which led to the execution of the Britannia and Conway tubular bridges, have safely demonstrated the great strength of hollow tubes of that metal, and have induced the adoption of the tubular system of metallic construction, in a constantly increasing variety of forms and uses. Of such applications, I am convinced that one of the most important will eventually be in the construction of masts of sufficient strength, to support themselves without the extraneous aid of the usual standing rigging.

Fig. 1.



A conical tube of wrought iron, six feet in diameter at its base, and with plates an inch thick; or, what would be still better, two concentric tubes, each of half-inch plates, and riveted together by means of intervening strips of metal, or transverse stays, would advantageously replace the mainmast and shrouds of a ship of 2000 tons. The weight would be the same, and thus, so far as "top-hamper" is concerned, no disadvantage would result. It is also obvious, that the upper parts of the mast might be constructed to slide within the lower parts, so as to secure the conveniences occasionally derived from lowering the topmasts of an ordinary

* From the London Practical Mechanic's Journal, August, 1852.

ship. The following advantages may be expected to arise from the use of the iron self-supporting mast:

1st. Its strength would be greater than that of its timber competitor, whilst it would, at the same time, be more evenly distributed.

2d. Less resistance would be opposed to the wind, in the ratio of about 2 to 3.

3d. In consequence of the absence of the stays and shrouds, the foot of each sail might be attached to the yard at several places in addition to the clews, and thus a greater effective area of canvass would be obtained, and the tendency to "balloon" would be prevented.

4th. The yards might be braced up to as small an angle with the keel line as the seamen could possibly desire, and hence the sails would be turned to the best advantage when sailing on a wind.

Fig. 1 represents a horizontal section of my proposed duplex concentric tubular mast, taken near its base, the tubes being each of half-inch iron, riveted together by the stays, A.

[Masts of tubular wrought iron have already been used to some extent, but only, so far as we are aware, for large steamers. One or two large iron ships, of Clyde build, have been so fitted, but we are not in possession of their actual details of construction, or their behaviour at sea. Telescopic bowsprits, to work on the principle proposed by Mr. Joule for striking the topmast, have also been patented by Mr. Borrie, but they have not yet come into regular use, although we know that the weight of such constructions in tubular wrought iron is only two-thirds that of the same details in pine. It is, in fact, scarcely possible to overrate the advantages derivable from such a system of construction, for, whilst greater strength is obtainable, with less dead weight, than when timber is used, the telescopic plan furnishes great facilities in the transport of vessels in harbor, as well as in easing their laboring at sea, and enabling them to carry a press of sail much longer. In bowsprits, the jib boom running inside keeps the strain directly on the centre, and obviates the severe twisting strain usually experienced at present in a sea way. Masts and spars also partake more or less of these advantages. Besides, the great losses from the natural decay of timber, and the heavy expense of replacing sprung bowsprits, lower and topsail yards, must be enormously diminished with the employment of tubular iron; and the great improvement in appearance, in comparison with the confessedly clumsy bowsprit, jib boom, and topmasts, is a point by no means to be disregarded.—Ed. P. M. Journal.]

Process for giving Various Objects a Pearly Lustre. By O. Reinsch.*

To produce the iridescence of mother-of-pearl on stone, glass, metal, resin, paper, silk, leather, &c., Reinsch adopts the following process:—2 parts of solution of copal, 2 parts of that of sandarach, and 4 parts of solution of Damara resin (equal parts of resin and absolute alcohol), are mixed with half their volume of oil of bergamot or rosemary. This mixture is to be evaporated to the thickness of castor oil. If this varnish

*From the London Chemical Gazette, June, 1852.

be then drawn by means of a feather or brush, over the surface of some water, it will form a beautifully iridescent pellicle. This film is now to be applied to the objects which are to be rendered iridescent. The vessel in which the water is contained, on which the pellicle has been produced, must therefore be as large as, or larger than, these objects. The water should have about 5 per cent. of pure solution of lime added to it; its temperature should be kept at about 72°. The objects are dried in the air.—*Kunst und Gewerbebl. für Baiern*, 1852, p. 165.

For the Journal of the Franklin Institute.

Remarks upon Maynard's System of Priming for Fire Arms. By Wm. N. Jeffers, U. S. N.

If we examine the history of inventions, we find that at all periods the class of offensive weapons has exercised the ingenuity of men of all professions, and of this class, portable, or technically *small arms*, furnishes the greatest number. Their use and mode of fabrication being generally well understood, inventive genius has been able to produce the most varied combinations, in general intended to increase the rapidity of firing, and new efforts are being constantly made to adapt these inventions to the requirements of the military service. Hitherto, the principal difficulty has escaped the penetration of inventors; and, while repeating and revolving, breech-loading, and other arms, designed to supersede the musket, have multiplied, until nothing remains new or patentable but the improvement of the mechanical execution of some part of the machinery, the musket itself has suffered from a general neglect.

The progress of invention is generally with rapid strides, when the necessity for its exercise is made apparent, until a point is reached bordering upon absolute perfection; but if we trace back to the fifteenth century the successive improvements which have been made upon the musket, we are astonished that so little has been in reality accomplished.

The invention of cannon having preceded that of portable guns, it was not until the latter part of the 15th century, that a weapon was produced resembling the musket in having a wooden stock, and intended to be supported at the shoulder with the left hand, while fired by a match held in the right. The improvement of this weapon, by the addition of a bent lever, one end of which formed the trigger, the other end carrying a lighted match, which by a movement of the lever could be brought in contact with the priming, occupied another half century, and at this point the Chinese still rest. The next step was the invention of the wheel lock; in which, by the friction of a revolving wheel upon a composition, a shower of sparks was produced, which inflamed the priming: but it was not until 1540 that fire arms entirely superseded the bow and the sling. Sixty years later, the invention of the flint lock gave to the musket its character, and at the end of the seventeenth century, the match lock was finally abandoned.

Two centuries, and those the most prolific in inventions, have elapsed, and the flint lock is still the most common means of igniting the charge in sporting guns; and experienced officers do not hesitate to declare, that in the hands of undisciplined troops, the flint has upon the whole an advantage over the percussion system, as at present arranged. The principal, and, since the invention of the cartridge by Charles XII. of Sweden, almost the only defect in the musket which remains to be overcome, lies in the mode of igniting the charge.

The objections to the flint lock are so generally known and appreciated, that it is unnecessary to repeat them. But the simplicity of the percussion lock; the greater certainty and rapidity with which the charge is ignited; the security from dampness in fogs or rain; the diminution of the charges, and their equality, both of which are conducive to accuracy of firing; the capability of firing a greater number of rounds before cleaning the gun; and various minor but positive advantages which the system possesses over the flint lock, are not sufficient to balance the inconveniences resulting from the difficulty of placing the cap at night, with clumsy fingers, when benumbed with cold, or during the excitement of battle.

To obviate these inconveniences, unwearied efforts have been made to arrange machines for placing caps upon the cone, some attached to the gun, others used by hand, all of which having failed to perform the object, have passed into collections of sporting curiosities. Not satisfied with the cap, which had been generally adopted after long trial had proved it to be with its many disadvantages superior to all other previously known methods, inventors have lately exhumed old and invented new arrangements, until all possible arrangements of reservoirs for pills, tubes, and wafers, would appear to have been tried, and found to be totally unfit for arms in common use, whether placed by hand or the action of machinery. For sporting purposes, therefore, the evil has been suffered to exist; in the military service, one evil has been substituted for another, by enlarging the cap to such a size, weight, and strength, as to be tangible to fingers more accustomed to the mattock than the hair trigger.

This cap, even when made of pure copper, well annealed, that no bits may be blown off to the damage of face and eyes, opposes such a resistance to the blow of the hammer, that it is necessary to form the main spring of the musket of such strength as to require a weight of *eighty-five* pounds to bend it up to the cock notch. Some idea of the force of the blow can be obtained from the fact that the top of the cap is sometimes cut off, and a piece of the copper forced into the vent, which can with difficulty be cleared by digging out the copper with the point of a knife. The effect of this shock on the side of the barrel, in increasing the vibrations and twisting the musket out of the line of aim, aggravated by the difficulty of pulling the trigger, can only be appreciated by those in the habit of handling the arm. For sporting guns, caps are not always made and annealed with sufficient care; hence the necessity for the inconvenient and unsightly snail shell guard, to protect the eyes from flying fragments of copper; and the slight adhesion of the fulminate to the bottom of the cap makes necessary the well known precaution which expe-

rienced sportsmen exercise, of examining each cap before putting it on the cone, to see that the priming has not dropped out. The caps must be carried in a pouch or pocket, from which, if easy of access, the caps are spilled or lost; if securely closed, it is difficult to open, and the operation occupies a considerable time.

The objections to the cap system in the military service, and generally applicable to sporting arms, may then be briefly summed up as follows:

1. The caps are necessarily separated from the gun and the cartridge box, to be carried in a separate pouch, from which they are easily lost, and taken with difficulty.

2. After firing, the motions of half-cocking, handling and placing the cap, and letting down the hammer to secure the cap, occupy, with the best drilled troops, at least one-third of the total time required to re-load; with raw troops, a longer time is required to cap than load.

3. Placing the cap is at all times difficult; but at night, when the sense of touch is the only guide, or with benumbed fingers, it is frequently impossible.

4. A slip from half-cock, or a fall, whether the hammer is down or not, may and often does explode the cap, producing serious accidents.

5. The necessary strength of the springs of the lock seriously affects the accuracy of firing; and when we consider the cost of bringing a soldier in front of an enemy, it must be admitted that no pains ought to be spared to remove, or at least diminish, every cause which militates against the effectiveness of his fire.

If then the cap system is liable to so many and such serious objections, it may be asked, if there is no probability of the discovery of a preferable system? We answer, that such an arrangement already exists; and, were it not that the same force of prejudice and habit still exists, which retained the match lock in service for half a century after the invention of the flint lock, the *Maynard* system of priming would be universally adopted.

In the year 1844, Dr. Edward Maynard, of Washington, an élève of the Military Academy, had his attention directed to this subject. After study and experiment had perfected the idea, he published in 1845 his invention of an entirely new system of priming; in which, retaining from what was already known only the percussion principle, were combined the following leading features, which we mention in what we consider the order of their importance:—simplicity; absolute safety from accidental explosion of the magazine; complete isolation of the separate charges, and yet their union in one piece easily managed by clumsy fingers; exemption from deterioration by exposure to dampness; facility and certainty of fire; increased rapidity of fire; facility of inspection without displacing any of the parts; applicability to existing models of fire arms at a small cost, without requiring any alteration in their form; less expensive than the cap system: all of which advantages it is believed were attained by an arrangement of which the following is a description:

The detonating material of the "Maynard Primer" is in the form of little circular lozenges, each about one-fifth of an inch wide and one-thirtieth of an inch thick. These lozenges are enclosed between two

narrow strips of strong paper, cemented together, and rendered water-proof and incombustible. The strip thus formed is a little less than one-fourth of an inch wide, is very stiff and firm, and contains five of these lozenges (each of which is a *charge*,) in every inch of its length; the charges forming little projections of their own shape, on one side, having considerable and equal spaces between them; the other side of the strip being one flat and even surface.

One of these strips containing fifty or more or less charges, is coiled up and placed in a pear shaped magazine milled into the lock plate just in advance of the hammer, and is fed out by the action of a finger pivoted to the tumbler of the lock, one charge at each time the hammer is raised from half-cock to cock. When the hammer descends, it cuts off and fires the charge fed out upon the vent (or nipple if one is used) of the gun, thus igniting the powder of the cartridge in the barrel; the finger is withdrawn behind the next primer, ready to thrust it forward on re-cocking, while a stationary spring holds the coil.

"These primers are made by a machine capable of making a million per day, at about one-tenth the cost of the percussion caps in military use."

Comparing this arrangement with the existing system, the following advantages claimed by the inventor, are made apparent to the most superficial observer:

1. The soldier applies one coil of priming containing sixty charges (one half more than he has cartridges) to his musket when he has leisure, and has nothing more to do with the priming until these sixty rounds have been fired; hence, in loading, the whole manipulation of "priming" in action is dispensed with; and, according to the testimony of Brevet Major Larkin Smith, with a gain of an increased rapidity of fire of thirty per cent.

2. By the motion of the hammer from "half-cock" to "cock," the gun primes itself with a mathematical precision unattainable by hand, without regard to its position, or to heat or cold, by night or day, in fair weather or foul, whether the soldier be in haste or at ease, attentive or not, skilful or awkward.

3. The primer cannot be fired with the hammer "down" or at "half-cock," nor can it be accidentally separated from the gun, or damaged by being jolted or knocked about with the gun.

4. No jarring, such as is produced by coming to "order arms" upon a stone, or striking the hammer in getting over fences, or catching it among the limbs or twigs of trees, or the dress, or trappings of horses, or rigging of vessels, or any similar disturbance of the lock can fire the primer.

5. The priming requires no tools or appendages, and but a moment's explanation, to be perfectly understood and applied by the soldier.

6. No pieces of metal or other annoying substances are thrown off from the primer.

7. It costs about one-tenth as much as the copper caps now used in the service, occupies less than one-fourth their space, (five hundred primers may be carried in a cylinder occupying in the cartridge box, or elsewhere,

the space of one cartridge,) is of about one-twelfth their weight, and is equally proof against the effect of any climate.

Frequent and prolonged trials in the presence of boards of experienced officers have proved that these advantages exist; but in order that any proposed system, although apparently preferable, should supersede an existing one, it is not merely requisite that it be superior, it is also necessary that it possesses marked advantages, and that these advantages be demonstrated by experiments made under circumstances analogous to those in which troops are placed exposed to all the vicissitudes of service in war. In military affairs, experiment is the only safe guide, and what experiment fails to demonstrate, it is as well to deny, or at least to doubt.

This invention has been submitted to that test, and its superiority over the cap system abundantly proved. Having been for several years subjected to the most rigorous criticism by experienced officers, whose scrutiny had been invited, a hundred real and imaginary objections to the system had to be met and overcome by its author, before the musket, altered from the flint lock in the most clumsy manner to save the expense of half a dollar on each, was placed in the hands of two companies of troops serving in Texas. After some months of exposure, equal in all respects to the circumstances of an active campaign, the most favorable reports were made by the officers commanding the companies, and the report of Major Larkin Smith, one of these officers, winds up by giving as the opinion of himself and other officers who have had practical experience and observation of it for military use, "that it will supersede the cap system."

Toward the close of the Great Exhibition, this invention, which at first, from its great simplicity, and the universal belief that the musket was not susceptible of improvement, was entirely disregarded, assumed a position due to its merits, and riveted the attention of the military of Europe. The defects of the cap system had been felt and acknowledged by them, and their endeavors to obviate these defects had led to a somewhat extended adoption of the needle musket, in which the charge is ignited by friction. Nothing but the advantage of doing away with the cap could have recommended this most objectionable arm to a favorable consideration; it combines all the worst features of the breech loading system, with those peculiar to the union of friction powder with the cartridge.

The Maynard system is now being experimented upon in England, by a board of distinguished officers, the report of which cannot but corroborate that made by our own; and, should not prejudice or interest interfere, we may expect that it will speedily be adopted.

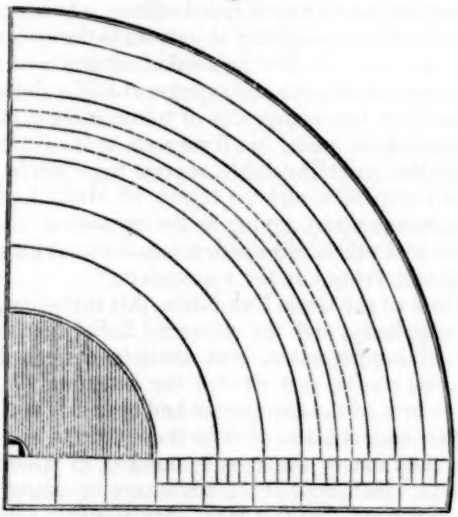
In our own service it is steadily working its way into favor; but the principal obstacle to its general adoption is the want of accurate knowledge of its construction and mode of operation; a knowledge which the writer of this notice, from a sense of its great merits, has endeavored to extend. We leave this subject, trusting that this invention may be examined without prejudice, and with the attention due to its importance; an importance which may be more readily appreciated when we state that at a saving of expense it doubles the efficiency of our arms.

For the Journal of the Franklin Institute.

The Theory of the Main Spring of a Watch; showing how to select and adjust one that will fit in every respect, without having to try it in the Barrel. By ALEXANDER YOUNG, Camden, S. C.

Figure 1 is an enlarged sketch of one-fourth part of the spring barrel of a watch. It is laid off into nine equal spaces, eight of which are to show the theory of the action of the spring. The centre space is for the arbor, and is one-third of the diameter. There is a scale of twenty-four equal parts, corresponding to the thickness of the spring, which is estimated by the proportion it bears to the diameter of the barrel: suppose it to be 72 to 1.

Fig. 1.



Two coils of the spring placed in the outside space will then fill it, and if wound on the arbor will fill the inside space, making five coils; if it is attached to the barrel and arbor, as usual, it will cause three revolutions in expanding back to its first position. Nineteen coils will fill the seven outward spaces; and if wound on the arbor, the seven inward spaces with twenty-two coils; having the same difference and revolutions as above, but with greater power, and the action will be more uniform.

Nine and one-sixth coils will fill the four outside spaces, and when wound on the arbor, the four inside spaces increased by five and two-thirds coils. The spring has most action when it fills four spaces, or half the barrel; if it extends to the middle of the fifth space, it will lose one-sixteenth; if to the whole five spaces, one-quarter of a revolution, but will gain in power, and transmit it more uniformly. A scale for any thickness of spring can be applied to the same figure.

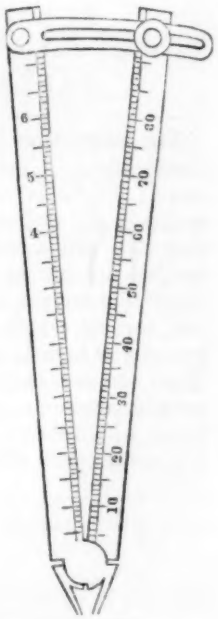
Table of the radius of the circles that divide the spring barrel into nine equal spaces; also, the revolutions taken from them, which are equal to the number of coils that the spring has when wound on the arbor over the number it has when expanded against the rim of the barrel.

The two middle spaces are subdivided; the radius of the two circles and the revolutions made by those divisions are interlined.

Radius of the Circles.	Revolutions.
36,000	
33,940	2,910
31,754	4,531
29,392	5,392
28,142	5,597
26,832	5,664
25,455	5,597
24,000	5,392
20,777	4,531
16,970	2,910
12,000	

The drawing, fig. 2, shows the form of the callipers and sector combined; the long end is four inches, and is divided from the centre of the joint on both legs, into one hundred equal parts; the divisions opposite to 60, 70, and 80, are marked 4, 5, and 6, corresponding to the numbers for the revolutions of the barrel. In the tables it has a clamp and screw limiting its opening to one inch.

Fig. 2.



The short or calliper end, is four-tenths of an inch, opening to one-tenth, or as ten to the distance across from any two corresponding numbers on each leg of the sector.

The following table shows how many revolutions of the barrel will be produced by the different thickness of the spring. A deduction is made for attachments at the ends, and for the soft part of the spring not unwinding from the arbor, and may amount to one-third of a revolution for a spring of one-eightieth, and to three-quarters, when it is one-sixtieth of the diameter.

Coils of the spring to the diameter of the barrel.	Revolutions by theory.	Revolutions by experiment.
60	4·72	4·0
62	4·88	4.2
64	5·04	4·4
66	5.19	4·6
68	5.35	4·8
70	5·51	5·0
72	5·66	5·2
74	5·82	5·4
76	5·98	5·6
78	6·14	5·8
80	6·30	6·0
82	6·46	6·2
84	6·61	6·4

To select a spring for any number of revolutions, open the sector to the radius of the barrel, at the number on the scale, for the required revolutions, the callipers will then just admit five coils of a spring when of a suitable thickness.

To find the weight of a spring for any size of barrel, take the inside diameter in hundredths of an inch, which is done by opening the sector to its limit, then apply the barrel cap to reach across from side to side, to the same numbers on the counterpart scales, which will be the diameter. The width of the spring is found in the same way. Then enter the table with the diameter of the barrel, take out the three opposite figures, and multiply by the width of the spring, which gives the weight in troy grains for a spring that will fill nine-sixteenths of the barrel.

The table is constructed by taking the area of the arbor from the area of the barrel in hundredths of an inch; nine-sixteenths of the remainder multiplied by 1900, the grains, in a cubic inch of watch spring, gives the numbers for the table.

If the arbor is less than one-third of the barrel, the callipers should fit tightly, and the spring have full weight; if larger, the callipers should fit loosely, and the spring have short weight.

Table of the diameter of the barrel in hundredths of an inch.

50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
1·86	1·94	2·02	2·10	2·18	2·26	2·34	2·42	2·51	2·60	2·69	2·78	2·87	2·96	3·05	3·15	3·25	3·35	3·45	3·55	3·65	3·76	3·87	3·98	4·09	4·20

Weight of the spring in grains, troy, for every hundredth of an inch in width.

The next table is constructed by experiment with a spring twelve-hundredths ($\frac{12}{100}$) of an inch wide, filling five spaces, or five-ninths of a barrel, $\frac{67}{100}$ths of an inch in diameter, of which the thickness of the spring is $\frac{1}{78}$, and weighs 45 grains. The barrel having the chain lapped round it, with a scale for weights, and held fast by the arbor, when the weights are put in the chain, will unroll; the weights required for each revolution are noted, and placed in the table. The spring is then taken out, and its length reduced by breaking off 4½ grains; when replaced, proceed as before, placing the results in the second column of the table. Then remove another 4½ grains, leaving 36 grains of the spring. The weights applied as before, gives the numbers for the third column of the table, which shows the intensity of the spring at the end of each of the five revolutions; when it fills five, four and a half, and four spaces.

	Troy ounces sustained.	Ounces sustained; four and a half spaces filled.	Ounces sustained; four spaces filled.
	9	8	7¼
	12	11	10¼
	14	13	12¼
	16	15	14¼
	18	17	16¼
Sum,	69	64	60¼
No. of revolutions,	5⅝	5⅝	5⅝

The sum for each column gives the weight raised to a height equal to the circumference of the barrel. The greatest amount of power is obtained when the five spaces are filled; with four only, there will be more left over the five revolutions, but not sufficient to compensate for the loss of power.

The spring of the best watches fills four and a half spaces, and has a revolution over, to allow for straining up, and still leaving a part free.

The sector, the table, (which can be copied on a card,) and a pair of small scales, with grain weights, are all that is required to select a spring that will have the desired number of revolutions, and the greatest power the capacity of the barrel will admit.

On the Manufacture of Hydrocarbon Coal Gas from Boghead Coal. By Andrew Fyfe, Esq., M. D., F. R. S. E.*

In a paper published in the *Journal of Gas Lighting* for July, 1850,† I drew the attention of the public to the quality of resin and water gas, and then stated that the gas thus produced had not the high value that was ascribed to it by those who had introduced it, and that, consequently, its introduction as a source of light ought to be abandoned. That I was correct in my conclusions, has been proved by the process having been given up by its most strenuous supporters, and by the patentee himself. Since that time, attention has been drawn to the influence of water over coal gas, and marvellous accounts have been made public of the enormous saving that is to be effected by the introduction of what is now styled "hydrocarbon gas from coal."

In my report on Boghead cannel coal, published in November, 1850, after stating the remarkable qualities of that coal for the purpose of illumination, I concluded by observing:

"It is valuable, not only on account of the large quantity of gas which it affords, and for the high illuminating power of that gas, as indicated by the photometer—it will be found also to be extremely valuable from the large quantity of matter condensable by chlorine which it contains, and which is the principal source of light. Accordingly, were Boghead coal gas mixed with gas from inferior kinds of Parrot coal, and from English caking coal, it would add greatly to their illuminating power; or, which is the same thing, were Boghead gas *diluted* with gas from these inferior coals, while the quantity of gas would be increased, the illuminating power of the Boghead coal gas, as indicated by the photometer, would, most probably, be very little diminished. I conceive, therefore, that the Boghead coal will be of great use to those using inferior kinds of coal in the manufacture of gas, such as the poorer Scotch cannel coals, and especially the English caking coal."

At the time that I made the above remarks, I had in my mind gas, not only from *inferior kinds of coal*, but also from water, by the hydrocarbonizing process, with the view merely of *diluting* the rich Boghead gas, and of enabling us to consume it advantageously; as I conceive that, by the methods in use for burning gas, those rich in matter condensable by chlorine are not so consumed as to make them give the light that they ought to yield, were they properly burned. Since the publication of that report, I have been anxious to put these opinions to the test of experiment; circumstances, however, have prevented me from doing so till within the last few weeks. Having lately had the opportunity of thoroughly investigating

* From the London Mechanics' Magazine, July, 1852.

† Republished in *Mech. Mag.*, vol. LIII., p. 92.

the subject, I shall now enumerate the results. These trials, I may state, were undertaken solely with the view of ascertaining whether the use of water would in any way prove beneficial in the manufacture of coal gas for illuminating purposes; and as I thought that Boghead coal, from its great quantity of volatile matter, and from the high per centage of matter condensable by chlorine in its gas, would be most likely to prove the truth or fallacy of these opinions, I have confined my trials entirely to it.

In considering the hydrocarbon process, as it is now generally styled, two important questions occur:

1. Is there any increase in the *amount of light* obtained from a given weight of coal?

2. Is there any economy in using the water and cannel coal gas, instead of that from Boghead alone?

In the experiments, the results of which I am now to give, the Boghead coal that was used was that with which the gas works at Aberdeen have lately been supplied for the manufacture of their gas.

In my printed report on the value of Boghead cannel, I gave the results of my trials on that which was at that time sent to the works, as yielding 14,800 feet of gas per ton; having 27 per cent. of matter condensable by chlorine, one foot of which gave the light of 7·72 sperm candles burning 140 grains per hour—that is, 9·4 candles of 120 grains; thus making one foot give the light of 1080·8 grains of sperm; the gas per ton of coal was, consequently, equal to 2283·2 lbs. of sperm.

To secure accuracy in the trials with water, the quality of the Boghead coal to be used was first ascertained. For this purpose a quantity of it was broken to pieces, and set aside for the experiments, both on the coal alone, and for the water process. Six trials were made at different times, in the usual way, excepting that the heat was higher than in the trials formerly reported on. Seven pounds of coal were used in all the trials. The following are the results. The durability is that of a cubic foot burnt through a jet one thirty-third of an inch in diameter, and 5-inch flame. The candle is one burning 120 grains per hour.

The average of these trials gives one foot of gas, equal to 11·79 candles of 120 grains, and the gas from a ton of coal equal to 3253·5 lbs. of sperm: a much higher quantity than I got before; but it must be kept in recollection that it was this cargo of coal on which the water trials were made.

Cubic feet per ton.	Specific gravity.	Condensation by chlorine.	Durability.	Argand 58 holes consuming ft. per h.	Illuminating power 1 ft.=candles	1 ft.=grs. sperm.	Gas of 1 ton=lbs sperm.
			m. s.				
15,866	595	23·75	75 50	4·00	10·57	1260·0	2856·0
15,413	738	26·00	85 50	5·05	11·62	1399·2	3082·0
17,680	698	23·00	83 20	3·06	12·12	1454·6	3674·0
16,320	652	20·00	80 00	3·77	11·93	1431·6	3337·6
15,866	637	20·00	79 20	4·00	11·96	1435·5	3255·0
15,413	689	21·05	82 00	3·87	12·55	1506·0	3315·9
16,093	650	19·75	81 03	4·12	11·79	1414·5	3253·5

In conducting the trials with the Boghead and water together, I had

recourse to an apparatus similar to that erected by Mr. White at Grand Holm, in the neighborhood of Aberdeen, and to those used at Manchester and other places. It consisted of two iron retorts; one for the generation of water gas, the other for the coal gas. Each retort was 2 feet 6 inches long, ⊓-shaped, and 9 inches wide. In each there was a diaphragm, passing from the mouth to within 3 inches of the other extremity, dividing it into an upper and under compartment, shut off from each other, excepting at the back end. Both compartments of the water retort were filled with charcoal, and a tube from a tank conveyed water into its upper compartment, by which the water was made to pass first through the charcoal in it, and then in the lower one, from which the gas generated, along with surplus steam not decomposed, passed through the coals into the lower, and then into the upper compartment of the coal retort. From this it proceeded to the hydraulic main, the condenser, and purifier, to the gasholder, in the usual way. In all the trials two gasholders were used; these were exactly of the same dimensions, were nicely equipoised, and accurately graduated. The whole of the gas thrown off was propelled into them uniformly in the same ratio during the whole of the performance of the experiment, as was proved by their rising in the same ratio; but, to secure accuracy, the gas in each was tested, and found to be of the same composition. In manufacturing the gas, sometimes the usual heat, sometimes a higher, occasionally a lower heat, was resorted to. In ascertaining the illuminating power by the Bunsen photometer, a sperm candle, burning 140 grains per hour, was always employed, and then proportioned to one consuming 120 grains, so as to enable me to compare the results with those of other experimenters. The gas was burned by a 58-hole Winfield Argand; and different trials were made with each gas, to find out the most profitable consumpt. It is unnecessary for me to record all the trials; I leave out those made at first with the view of finding out the proper mode of proceeding, as I found that the process is a very uncertain one, the results varying very much, even when it seems to be conducted under similar circumstances.

The following is a tabular view of the results of the eight trials:

Cubic feet of gas per ton of coal.	Specific gravity of gas.	Condensation by chlorine.	Durability jet $\frac{1}{33}$, 5 inch flame.	Argand having 58 holes consuming ft. per hour.	Illuminating power per foot = candles 120 grains.	One foot = grains sperm.	Gas per ton = lb. sperm.
39,893	434	8·05	35′ 45″	8·0	4·61	553·2	3152·6
39,893	453	9·33	40 50	8·0	5·25	630·0	3590·0
39,893	536	11·00	43 00	9·0	5·13	615·6	3508·0
38,986	646	12·00	46 40	7·2	5·46	655·2	3649·0
38,986	666	11·00	44 10	7·2	4·08	489·6	2726·5
39,893	663	12·75	46 00	7·2	4·85	582·0	3316·8
39,896	600	11·33	46 30	7·5	5·02	601·2	3426·5
38,986	606	11·25	42 40	8·3	3 05	420·0	2339·0
39,553	575	11·44	43 20	7·8	4·73	568·5	3213·5

In the two first and the two last of these trials, the production of gas was continued till the desired quantity was obtained. In the others, it

was carried on during the same, or nearly the same length of time, that by previous trials was found to be necessary for carbonizing the same quantity of coal alone. In these instances, the water was more rapidly propelled through the retorts than in the others, especially towards the commencement of the process.

These trials show that the process is very uncertain in its results, even when it is conducted under similar circumstances. The average of all the above mentioned trials is, that from a ton of Boghead coal by the water process, there are obtained in this way 39,553 feet of gas, each foot of which gives the light of 4·73 candles, burning 120 grains per hour; that is, 561·5 grains of sperm, making the gas from a ton of coal give the light of 3213·5 lbs. of sperm.

These results may be considered as what the hydrocarbon process will yield; indeed, they nearly correspond with those given by Dr. Frankland and Mr. Clegg; for, though the quantity of gas is inferior, yet the illuminating power of each foot is superior, and thus the pounds of sperm per ton of coal are nearly the same.

Dr. Frankland, in his Report, (*Journal of Gas-Lighting*, January, 1852,) states that from Boghead cannel he obtained 13,240 feet of gas per ton, the illuminating power of which per foot was 10·52 candles of 120 grains; consequently, each foot was equal to 1262·4 grains, and the gas of the ton was equal to 2387·7 lbs. of sperm. In my trials the average was 3213·5 lbs. per ton; therefore, 34 per cent. beyond his. From Boghead and water Dr. Frankland got 51,720 feet per ton, the illuminating power of which was equal to four candles per foot; and the total quantity was, therefore, equal to 3546·5 lbs. The average of my trials was 3213·54 lbs.

Mr. Clegg, in his Report, published after most of the foregoing trials were made, has given very nearly the same results. He obtained 52,000 feet of gas from a ton of Boghead coal by the action of water, each foot of which was equal to four candles—that is, to 480 grains of sperm; the total quantity was, therefore, equal to 3515·7 lbs. We may, therefore, consider the results of my trials as correct; and thus confirming to a certain extent, those of Dr. Frankland and Mr. Clegg; viz., that from a ton of Boghead coal, by the action of water, a quantity of gas can be obtained which, when properly consumed, will give the light of about from 3200 lbs. to 3400 lbs. of sperm. They differ, however, from them in two very important points; my gas, by the water process, though giving about the same light, was not nearly so great in quantity; it was about 24 per cent. less. Again: in Dr. Frankland's trials, the quantity of gas from Boghead coal amounted only to 13,240, and the pound of sperm to 2387·7 per ton of coal. The increase in quantity of light, by the water process, was, therefore, 47 per cent. In my trials, though the amount of sperm per ton was in some a little more, yet *the average of all the trials gave a little less by the water process than by Boghead alone.* I think that this may be satisfactorily accounted for by the low results obtained by Dr. Frankland from the Boghead coal. I have never had a smaller quantity than 14,200 feet per ton, with one exception, in which case it was only 13,370 feet. Of twelve trials, the quantity varied from 14,200 to 17,680 feet. This may be owing to the low heat at which the gas was driven

off by Dr. Frankland, and which he states is the best, both for the coals alone and for the production of gas by the water process. On the contrary, I have found the best results are got from Boghead coal by using a heat higher than usual. The best result I ever had was that in which the heat was *very high*. In that case I got 17,680 feet; and, what is remarkable, the illuminating power of the gas was also higher; it was equal per foot to 12·12 candles of 120 grains; that is, equal to 2676 lbs. of sperm per ton of coal—a quantity *beyond that got by Dr. Frankland by the water process.*

The above remarks apply solely to trials with Boghead coal, so as to obtain from it a large quantity of gas, the illuminating power of which will be about 4 or 4·5 candles per foot; and, in my opinion, they are sufficient to warrant the conclusion, that though there is an increase in the quantity of gas per ton of coal by the water process, which no one ever doubted, yet that *there is no increase in light from the gas of a ton of coal compared with that obtained in those instances in which the carbonizing of the coal alone is properly conducted.*

Admitting the accuracy of the conclusion to which I have come, and which, in my opinion, the results of my trials warrant, I have next to consider whether there may not be a gain by obtaining a much larger quantity of gas, even though it is of inferior illuminating power.

The results of the trials which I am now to give, were conducted on a smaller quantity of coal, in the same apparatus. The heat of the water retort was kept high, to enable me to pass through it the requisite quantity of water, which, as has *been recommended*, was propelled as rapidly as could be done, towards the commencement of the process. The following are the results of five trials :—

Cubic feet of gas per ton of coal.	Specific gravity of gas.	Condensation by chlorine.	Durability jet $\frac{1}{33}$, flame 5 inch.	Argand feet per hour.	Illuminating power per foot = candle 120 grains.	One foot = grains sperm.	Gas per ton = lbs. sperm.
			m. s.				
52,133	466	5·75	35 20	8·0	2·01	252·	1876· 8
52,359	466	6· 5	35 30	9·0	1·91	229·6	1717· 4
52,352	460	6· 0	33 50	9·0	2·06	240·8	1801·14
51,680	460	5·25	35 00	9·0	2·11	253·4	1870·96
51,680	460	5· 5	34 10	9·0	1·81	217·	1602·
52,042	462	5·08	34 40	8·8	1·99	238·56	1773·06

These trials prove satisfactorily that there is, by this mode of operating, not only no gain, but actually a loss of light *to a very great extent.* From a ton of Boghead coal alone I got gas, the light of which was equal to 3253·5 lbs. of sperm. By this process, though the quantity of gas was great, yet the light of that gas per ton did not exceed 1773·6 lbs. of sperm, showing a loss of 1479·8 lbs. of sperm on the whole quantity—that is, 46 per cent.

Dr. Frankland states that he got 51,720 feet of 4 candle gas from a ton of coal, by the hydrocarbon process; making the pound of sperm per ton

equal to 3546·5. The gas of a ton of Boghead alone was in his experiments equal to 2387·7 lbs. of sperm, there being, therefore, according to him, an increase in the amount of light of 1158·8 lbs. of sperm—that is, of 48 per cent. In my trials, instead of an increase, there was a loss of 1772·3 lbs. of sperm on the whole quantity—that is, of 46 per cent.

How are we to reconcile these discordant results? I have already stated that, while Dr. Frankland got gas from Boghead alone equal to 2387·7 lbs. of sperm, I got gas equal to 3253·4 lbs. But Dr. Frankland's gas, when 51,720 feet per ton were obtained, was equal to 3546·5 lbs. of sperm; which, though an increase of 48 per cent. on the Boghead gas by his own trials, is only 9 per cent over the Boghead gas by mine. Why I have always had a loss instead of a gain, I cannot conceive. The only difference in the modes we have followed, in ascertaining the quality of the gases which we produced, is, that he received into his gasholder only a *part* of the gas as it was evolved from the coal, and of which gas only he tried the illuminating power; while I received the *whole* of the gas into my gasholders, and tested it. Surely my method is the more correct of the two, and claims more confidence in its results. Be this as it may, I conclude from these trials that, by the further use of water, no benefit is derived; indeed, that while the use of a small quantity of water does little harm in diminishing the amount of light, the use of a large quantity of water, with the view of procuring a large quantity of gas, proves injurious to a considerable extent. In further proof of this I give only one trial. In it the illuminating power per ton of coal was reduced in a very great degree.

Gas per ton.	Specific gravity.	Condensation by chlorine.	Durability.	Argand feet per hour.	Illuminating power 1 foot=cand.	One foot =grains sperm.	Gas per ton=lb. sperm.
			m. s.				
75,253	640	4·125	29 10	9	0·27	32·4	348·3

According to Mr. Clegg, 75,000 feet of gas, of 2·4 candles per foot, were got from a ton of Boghead—that is, equal to 2880 lbs. of sperm per ton. I could only get 345·5 lbs. How to reconcile these very discordant results I know not. I wish much that Mr. Clegg had stated the details of the process by which he succeeded in procuring this large quantity of gas, and how he ascertained the illuminating power. That there must be a great loss in all attempts to obtain a large quantity of gas from Boghead is evident. It is well known that, when this coal is carbonized at a low heat, it yields either a comparatively small quantity of gas, or, if the gas be in larger quantity, it is of low illuminating power. In trials with water, in which, with the view of obtaining a large quantity of gas, the water is propelled through the retort rapidly, to produce, as it is supposed, the full beneficial effect, the heat must be brought very low. Hence, probably, the cause of the loss in the illuminating power when we attempt to increase the quantity of gas.

Though, by the use of water to get a large quantity of gas from Boghead coal, there is no increase in the amount of light from the gas of a ton of coal, yet there may be some beneficial influence exerted when the

water is used, as to yield a much smaller quantity of gas. One trial was made in this way, and the following is the result:

Gas per ton.	Specific gravity.	Condensation by chlorine.	Durability.	Argand feet per hour.	Illuminating power 1 foot = candle 120 grains.	One foot = grs. sperm.	Gas of 1 ton = lb. sperm.
			m. s.				
24,932	554	11·75	48 20	6·8	6·51	781·2	2782·4

In this case, though the increase of gas amounted to 54 per cent., yet there was a loss of light in that obtained from Boghead alone to the extent of about 15 per cent.; still further proving that water not only does not exert any beneficial influence, but that, in most cases, it actually proves injurious, by reducing the total amount of light got from the coal in the usual way of carbonizing it.

The remark made regarding the uncertainty of the process is also still further proved by the above trial. It seems difficult so to regulate it as to obtain always the same results.

From what has now been said, I think I am still further warranted in coming to the general conclusion that, *in no instance is there any gain in the amount of light from Boghead coal gas by the agency of water in the method recommended by the advocates of the "hydrocarbon gas,"* and that, in those cases in which the quantity of gas is increased to a great extent, there is a decided loss by the agency of the water.

(To be continued.)

Specification of the Patent granted to GEORGE GWYNNE, *of the County of Middlesex, England, for Improvements in the Manufacture of Sugar.* Sealed February 27, Enrolled August 27, 1850.*

The first part of my invention will be found sufficiently detailed in the following description: a suitable oxide of lead, say for example, "litharge," is moistened with water, and is then subjected to a process of grinding until it is reduced to a smooth paste. When this is accomplished, twice its weight of refined sugar is added to it, and the grinding continued until these materials are properly combined. This result may be ascertained by putting a small portion of the mixture into a glass, stirring it up with some water, and after a few minutes upon slowly pouring it away. If the operation is perfect, no oxide of lead in a free state will be found at the bottom of the glass. This combination for distinction sake I shall call saccharate of lead. During the grinding, water is to be added from time to time, for the purpose of keeping the materials in a state of moderate consistency, and the generation by friction of such a degree of heat as will darken the sugar should be avoided. When the lead and sugar have properly combined, the mixture should be allowed to remain for forty-

* From the London Repertory of Patent Inventions, No. 705.

eight hours, when the saccharide of lead will be fit for use. During this latter period it may be well stirred up two or three times.

The application of this agent for the purification of saccharine matters is carried on as follows, but the details may be varied.

Some of the saccharide of lead is to be worked up with water to the consistence of cream, and passed through a fine sieve into the "blow-up" or other clarifying vessel.

The raw sugar with the necessary quantity of water is then to be added and the whole mixed together, when the steam or other heat is to be applied until the necessary temperature is attained, which my experiments lead me to consider is two hundred and twelve degrees of Fahrenheit, although it is possible that on the large scale a lower heat, say one hundred and eighty, may be found sufficient. The solution of sugar is now to be filtered through a bag-filter or other suitable filtering apparatus, and when perfectly transparent ("bright") is to be received into a suitable cistern.

In operating on cane juice, beet root juice, &c., I would advise the saccharide of lead to be substituted for the lime or carbonate of lime at present used. When the necessary quantity of this agent has been added, the juice is to be brought to the boil, and then filtered through a bag-filter or other suitable filtering apparatus.

It is, perhaps, unnecessary for me to observe that the quantity of saccharide of lead to be used will depend upon the quantity of the raw material; a little experience will enable the operator to ascertain the requisite proportion. I recommend that a trial should be made in the first instance at the rate of forty pounds of dry litharge to one ton of raw sugar of fair quality, and this proportion may afterwards be increased or diminished with other quantities of the same sugar to suit the manufacturer. As the impurities are more easily precipitated from cane juice, &c., than from raw sugar, it may be advisable to use a smaller proportion of saccharide of lead than is recommended above when operating on such saccharine matters.

After filtration it is necessary to remove a quantity of lead which has got into solution in the bright liquor or juice. There are several chemical agents, such as sulphuric acid, oxalic acid, hydro-sulphuric acid gas, sulphurous acid gas, acidulated ferro-cyanide of potassium, phosphate of lime, binoxalate of potassa, &c., which will render insoluble the lead. I however give the preference to a certain mixture, which can be made in the following manner:—

Calcined bone, "bone-earth," or "bone-ash," in fine powder, is to be well washed by repeated affusions of boiling water. The bone-earth is then to be made into the consistence of thin paste, and two-thirds of its weight when dry of sulphuric acid, previously diluted with four volumes of water, is to be slowly incorporated with it. These materials are then to be simmered for about 12 hours, frequent stirring being resorted to, and from time to time a little water is to be added as it evaporates away.

At the end of this time as much water is to be added as will reduce the mixture to the consistence of cream, when the whole is to be thrown into a conical linen bag to separate the clear fluid, and the residuum washed till the water ceases to taste acid. The strained fluids obtained as above are

then to be evaporated to about half their bulk, and when cold are to be filtered, and the filtered fluid is to be evaporated to dryness in a glass or other suitable vessel, and the mass resulting therefrom is to be heated to a dull redness for an hour in a platinum basin, and when cold is to be reduced to powder.

This powder is to be boiled with some water in a platinum or other suitable vessel; for two vessels constant stirring being employed, and water added from time to time as it boils away, and then to be filtered, and the residuum to be washed with boiling water till the water ceases to taste acid.

The different fluids obtained from the powder are then to be mixed together and brought to the boil, when a thin "cream of lime" is to be slowly added, stirring well at the same time, and continuing the boiling until a slight opacity appears, when filtration is to take place. The clear fluid solution of phosphate of lime, now obtained, is to be slowly stirred into a weak, say one part of soda and twenty parts water, and boiling solution of carbonate of soda until a very slight acidity is produced.

The white precipitate produced in the soda solution by the phosphate of lime is to be allowed to subside, when the clear fluid is to be drawn off, and evaporated to the point at which it begins to show crystals when quite cold. It is then to be mixed with the white precipitate above mentioned; this mixture, for distinction sake, I shall call phosphate of soda and lime; and, though I consider it the best agent for rendering insoluble the lead contained in the bright liquor or juice, I do not mean to confine myself to its use. I shall now describe the manner in which it may be applied.

I shall suppose the bright liquor or juice to have been received into a copper vessel, with a "steam jacket," and that the temperature of the fluid is about 180 degrees of Fahrenheit. Now mix in gradually as much of the phosphate of soda and lime as will render insoluble the lead.

The liquor or juice is now ready for filtration, but before this operation is performed it will be necessary to determine positively that the whole of the lead has been rendered insoluble.

After it has been ascertained by testing, as is now well understood, that the whole of the lead has been rendered insoluble, the liquor or juice is to be filtered through a bag filter, or other suitable filtering apparatus, for the purpose of removing the insoluble lead. The filtered liquor or juice may now be transferred into the vacuum pan or other suitable evaporating vessel, and at once converted into sugar, or, as a preliminary step to this conversion, the liquor or juice may be filtered through beds of coarse grained charcoal, in the manner now practised in many London refiners'.

Before I conclude the description of this part of my invention, I think it necessary to observe, first, that raw sugar may be used, instead of refined sugar, in the preparation of what I have called the saccharide of lead; secondly, that the saccharide of lead may be made by other processes than the one described by me, as, for example, by boiling together litharge, sugar, and water; thirdly, that the smooth parts mentioned in the early part of this specification, and which for distinction sake, I shall

call lead paste, is a powerful precipitator of the impurities contained in saccharine matters; and fourthly, that, although I do not recommend them, hydrated oxide of lead and oxide of lead itself may be employed for the purification of raw sugar, cane juice, &c.

When the lead paste is employed for precipitating the impurities from saccharine matters, it is to be used in the manner described for the saccharide of lead; but, like this agent, the details may be varied.

The hydrated oxide of lead can be prepared by dropping a weak solution of nitrate of lead (stirring well at the same time) into a weak solution of caustic potassa, leaving the latter very slightly in excess, throwing the precipitate in a filter to drain, and afterwards washing it with cold water, for the purpose of carrying away the nitrate of potassa. After being thus obtained, it may be used for the purification of saccharine matters, in the manner described for the saccharide of lead.

Although oxide of lead has little or no effect on the impurities of raw sugar when used in the manner described for applying the saccharide of lead, still it can be made to act strongly on these foreign bodies; as for example, by mixing together one part of finely powdered litharge, twelve parts of water, and twenty-four parts of raw sugar, and evaporating these materials with constant stirring in a water bath, until they attain the consistency of a very thick syrup, when they should be diluted by water to the density of thirty degrees of Beaume's saccharometer, at the temperature of 180, and then filtered. A good liquor will thus be obtained.

I will now describe the second part of my invention, which consists of a mode or modes of preparing and using the basic acetates of lead, or other combination of lead and acetic acid.

The lead paste acetate of lead (or an equivalent proportion of acetic acid) is to be added, in the proportion of about three parts of dry litharge to one part of acetate of lead; and these materials are to be prepared and used in the manner before described for the preparation and use of the saccharide of lead, although the details may be varied. These proportions give the highest basic acetate (hexacetate) known to chemists, but I think it necessary to observe, first, that a still smaller proportion of acetate of lead than above mentioned may be used; secondly, that the grinding up together of these ingredients is not indispensable, as an analogous result may be produced by introducing separately into the liquor or juice the lead paste and acetate of lead or acetic acid, as for example, by putting into the blow-up or other clarifying vessel containing the raw sugar or juice, some acetate of lead or acetic acid, and afterwards adding lead paste; thirdly, that hydrated oxide of lead may be substituted for the lead paste; and fourthly, that it is not absolutely necessary to prepare either the lead paste or hydrated oxide of lead, as oxide of lead itself may be substituted for these bodies, although not in my opinion with advantage.

I will now describe the third part of my invention, which consists of an improved mode of rendering insoluble the lead contained in the bright liquor or juice when the basic acetates of lead, sub-acetate of lead, for example, have been employed to purify the raw sugar cane, &c.

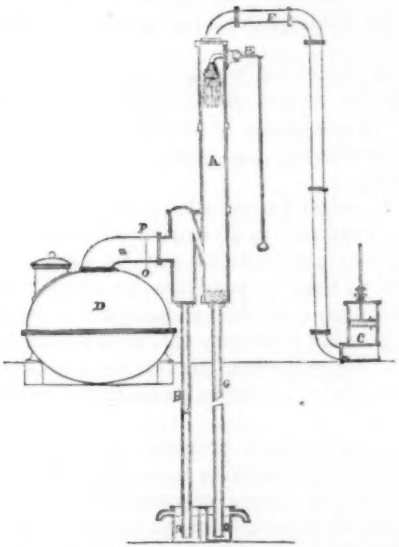
The agent which I prefer for this purpose is prepared in the same manner as the phosphate of soda and lime mentioned in the first part of

my invention, with this difference, that it is made slightly alkaline instead of slightly acid. This mixture, for distinction sake, I shall call alkaline phosphate of soda and lime, and it is to be used as follows, although the details may be varied.

I shall suppose the bright liquor or juice to have been received into a copper vessel with a "steam-jacket," and that the temperature of the fluid is about 180 degrees of Fahrenheit. Now mix in gradually as much of the alkaline phosphate of soda and lime as will render insoluble the lead.

The liquor is juice, and is now ready for filtration, but before this operation is performed it will be necessary to determine positively that the whole of the lead has been rendered insoluble.

After it has been ascertained by testing, as is now well understood, that the whole of the lead has been rendered insoluble, the liquor or juice is to be filtered through a bag filter, or other suitable filtering apparatus, for the purpose of removing the insoluble lead, and afterwards the liquor or juice may be converted into sugar.



Before I conclude the description of this part of my invention, I think it necessary to observe, first, that the phosphate of soda and lime may be used, instead of the alkaline phosphate of soda and lime. Second, that what I have called the white precipitate, which is produced in preparing the above phosphates, may be used in a manner different from that directed by me, as, for example, the clear fluids contained in these phosphates may be added to the bright liquor or juice first, and the white precipitate afterwards. Third, that the above phosphates, instead of being made slightly acid and slightly alkaline, may be made neutral. Fourth, that ammonia or potassa may be substituted for the soda contained in the above three phosphates; and, fifth, that the phosphates of soda, potassa, or ammonia, may be used as substitutes for the phosphate of soda and lime,

the alkaline phosphate of soda and lime, and the neutral phosphate of soda and lime.

I will now describe the fourth part of my invention, which consists of improvements in the vacuum pan, as referred to in the drawing. D, the vacuum pan; B, the receiver; H, a pipe inserted into the bottom of the receiver, B, and thirty-four feet long. It is shown broken in the drawing. This pipe dips into the small box, R, filled with water. A, the condenser; E, the injection cock for the admission of cold water; C, the air pump; F, the pipe of communication between the air pump and condenser; G, a pipe inserted into the bottom of the condenser, A. It is of the same length as the pipe, H, and dips into a similer box, Q, filled with water.

The following description will explain the mode of action:—Any liquor which boils out of the vacuum pan, D, falls into the receiver, B, and from thence down the pipe, H, into the box, R, from whence it flows away into some suitable receiver. The stream from the liquor in the vacuum pan, D, passes into the receiver, B, and from thence into the condenser, A, where it meets the injection water coming through the injection case, E, by which it is condensed, and falls to the bottom of the condenser, A, and passes from thence through the pipe, G, into the vessel, Q, from whence it runs away.

As the whole of the steam which is produced in the vacuum pan, will be condensed by the means above described, it must be obvious that nothing but the air contained in the liquor, or the air coming through leakages in the vacuum pan, can pass through the pipe of communication, F, into the air pump, C.

As there may be sugar houses where there is not a sufficient height to enable these improvements to be carried out in the manner shown in the drawing, the following substitutes may be used:—First, instead of the long pipes, G and H, small pumps may be applied in their places. Second, the exhaust arm, Z, of the vacuum pan, D, may be carried up such a height as will give the necessary elevation for the condenser, A, and the receiver, B. For the purpose of preventing any condensation in the exhaust arm, Z, it might be increased in another pipe between which steam might be admitted.

I am aware that it has been proposed to condense the steam arising from the vacuum pan by injection water passing through a pipe similar to the pipe, G. Now my improvements consist in the combination of the long pipes, and the air pump, or in the combination of the air pump and two small pumps used in the manner described above.

Having thus explained my invention, I wish it to be understood that I do not claim generally the use of basic acetates of lead in the manufacture of sugar; neither do I claim generally the separation of insoluble lead from saccharine matters by filtration through bag or other filters.

But what I claim is,

First, the use and application of saccharide of lead, whether prepared in the manner hereinbefore described, or in any other manner, of lead paste, and of oxide of lead, in the manufacture of sugar, and the use and application of suitable chemical agents for rendering insoluble the lead left in the bright liquor or juice through the use and application of saccharide of lead, whether made in the manner herein described, or in any other manner, of lead paste and oxide of lead. And I also claim the use of bag or

other filters for separating insoluble lead contained in the bright liquor or juice when such lead has been introduced through the use of hydrated oxide of lead.

Secondly, I claim the means herein described of preparing and using basic acetates of lead, or other combinations, lead, and acetic acid, in the manufacture of sugar.

Thirdly, I claim the means herein described of rendering insoluble the lead left in the bright liquor or juice when the basic acetates of lead have been employed to purify the raw sugar cane, juice, &c. And I also claim the separation of insoluble lead produced in the bright liquor or juice in the manner herein described by filtering the saccharine matters containing such lead through bag or other filters.

Fourthly, I claim the improvements herein described in the combination and working of vacuum pans.

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*Boiler Explosion.**

London has usually been very free from boiler explosions, although a great proportion of the engines in it are worked with high pressure steam. We regret, therefore, to have to record a very disastrous explosion which occurred on the 2d instant, at a saw mill at Wapping. The circumstances were rather peculiar. The boiler was of the belt shape, cylindrical, with flue through of $\frac{7}{16}$ plates; the ends were strongly stayed, the water was not low, and the pressure was only about 16 lbs. per square inch. The shell was 6 feet diameter, and we should have had no hesitation in working such a boiler to 40 or 50 lbs per square inch. Many boilers about Manchester, of 8 or 9 feet diameter, and the same thickness of plates, are doing so with great safety. In this case the bottom of the shell had become corroded, where it rested on the ridge of brick-work separating the two flues, to such an extent, that in many places not an eighth of an inch of sound metal was left. The boiler had given signs, by excessive leakage for several months, that the bottom was in bad condition, and it had been patched, but no investigation of it by any competent person had taken place. *Had the boiler been tested in its place by hydraulic pressure to 30 lbs. on the inch, the accident would never have happened, two lives would have been saved, and the proprietor would have been several thousand pounds the richer.* Such a scene of devastation as it occasioned it has never been our lot to witness before. Similar explosions have taken place at Burnley and Worcester, during the last few days, in both of which we suspect shortness of water will prove to have been the cause.

Self-Acting Plugs for Boats.†

To the Editor of the Artizan.

SIR:—The recent sacrifice of life which attended the loss of the *Amazon* and *Birkenhead* has called forth, among other inventions, that of a self-acting plug for boats.

* From the London Artizan for September, 1852.

† From the London Artizan, September, 1852.